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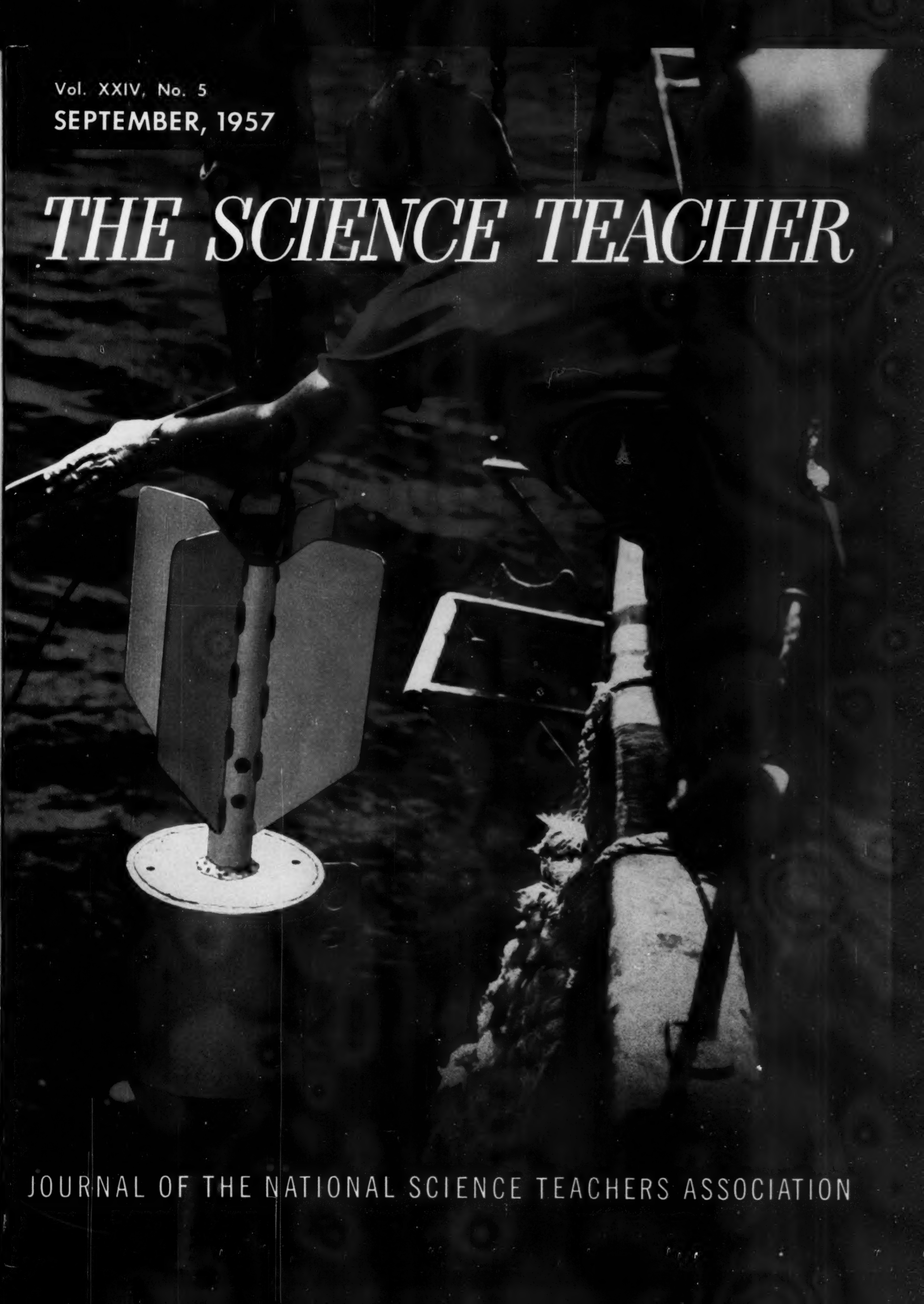
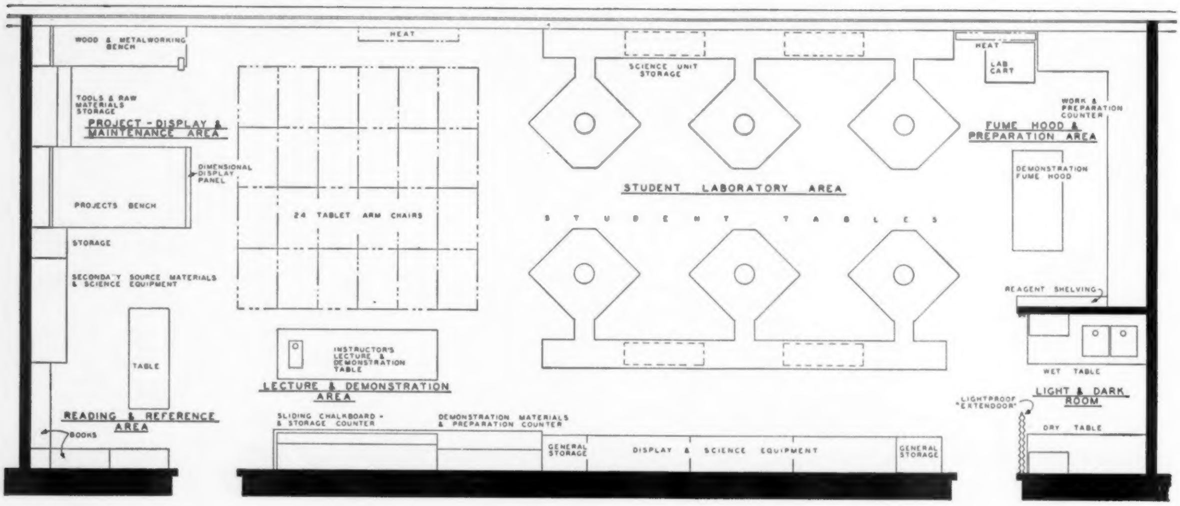
SEPTEMBER, 1957

THE SCIENCE TEACHER



JOURNAL OF THE NATIONAL SCIENCE TEACHERS ASSOCIATION



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THE SCIENCE TEACHER

Vol. XXIV, No. 5 **September, 1957**

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

THE SCIENCE TEACHER

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- Needed: Elementary School Science Consultants
- The New STAR Program

LAMONT GEOLOGICAL OBSERVATORY, COLUMBIA UNIVERSITY

THIS MONTH'S COVER . . .

shows oceanographers at work in one of the key types of activities that are going on during the significant International Geophysical Year, an 18-month "year" which began July 1. This particular photograph depicts oceanographers lowering coring apparatus from the side of the *Vema*, an oceanographic research vessel of the Lamont Geological Observatory. During IGY, the *Vema* will sail many seas, along with other U. S. vessels and those from other nations carrying out the IGY program to discover more about the earth and its atmosphere. Coring devices are designed to take samples of the ocean sediment; they are tubes about two inches in diameter, measuring 30 to 60 feet in length, which are lowered vertically with a heavy weight on the top. When they sink to about 100 feet from the ocean bottom, a small trigger weight releases the weighted tube which then falls into the bottom. The core is then withdrawn from the bottom and hoisted back to the ship. From this type of scientific investigation, oceanographers can learn how long the area was submerged, what it was before it was submerged, and important facts about ocean currents.

What is IGY all about? An updated revision of the definitive article published in *The Science Teacher* last May is available in reprints. They are free in reasonable quantities while they last. Write to the National Science Teachers Association, 1201 Sixteenth Street, N. W., Washington 6, D. C.

Editor's Column

The Editor gladly turns over his column this month to NSTA'S new President, Dr. Glenn O. Blough, Associate Professor of Education at the University of Maryland.

Another September—and we who teach science again look ahead to a school year of greater success than ever because children and young people depend on us to make it so. An unsuccessful farmer was once advised by a neighbor to consult the county agriculture agent for advice. "He can tell you a lot you ought to know about improving your farm," the neighbor said.

After a little thought, the farmer replied, "I doubt that I farm as well now as I know how." Perhaps we science teachers should this year concentrate on teaching as well as we know how. Some of us may be in the same boat with the farmer. . . .

For example, many of us know more things about how our pupils learn than we presently make use of. We know that motivation is essential to effective learning; but how much do we take this into account in planning and carrying out our teaching procedures? Are we concentrating on those who are already interested in science and leaving the others, who need the extra inspiration—and there are thousands—to go without, or become interested by accident? Are we dealing chiefly with those who would be successful without us?

We know also that all pupils do not learn at the same rate, or come to our classes with the same aptitudes, attitudes, skills, and potentials. Knowing this, do we teach them all alike, expect the same achievements from them all—at the same time and in the same way?

We are well aware that pupils succeed better, and so do we, if we keep well-defined goals in mind, and if the learners have a thorough understanding of them. Do we, then, keep our goals in mind—and do we spend some time showing our pupils that science is useful, that they live with it, that well-informed adults are at home with it, and that, to be unacquainted with it, is to be unfamiliar with today's scientific environment without which one is not equipped to live in today's world?

Do we, in other words, help these pupils to gain a real understanding of what a knowledge of the scientific method and the subject matter and science can do for them?

We know that growth in ability to solve problems and the development of a scientific attitude do not result automatically from having elected to take science and lived in the same room with a science teacher an hour a day for a semester. Growth in attitudes and skills are the result of teaching that concentrates on seeing that pupils do some scientific problem solving and thereby make use of a scientific attitude. Such teaching, if it begins in the grade school and continues throughout the school life of a pupil, can produce the desired results. We know that unless teachers intend to achieve these results, they will never do so. How vigilant are we in keeping our goals before us?

Glenn O Blough

Readers' Column

I was very much interested in the article, "The Case of the C.S.T.," in the May issue of *The Science Teacher*. I think that a reprint of this article should be sent to every school principal and every superintendent. It is sometimes difficult enough to do an adequate job when one is certified in the field; it is so much more difficult when a principal expects teaching on two different grade levels and, in addition, asks one to sometimes teach two or more different subjects. The author of this article (Edward Victor) did a wonderful job of presenting the facts.

I also want to offer my highest praise for your excellent packets and supplementary material such as the booklet, "This is Glass." I have come to consider *The Science Teacher* and the Packet Service as my "bibles" for reference material in the field of general science. I think you are doing an excellent job and, as an NSTA member, I feel that I am getting much more than my money's worth.

BILL ASH
Fort Oglethorpe, Georgia

I enjoy reading *The Science Teacher*. For a new teacher such as myself, it is an inspiration and a challenge to do better.

W. W. SHARKAN
Francis D. Raub Jr. High School
Allentown, Pennsylvania

I think the May cover of *The Science Teacher* is the most striking in many a "moon." To me this packs more appeal than pictures of buildings, cities where the convention will be held, etc. This ties in directly with a suggestion I wish to make as to the types of articles I would like to see in *TST*. To those of us not completely immersed in the field of science (I teach English, social studies, and junior high school education!), a good, brief, but authoritative article on science *content* would be helpful. The (Hugh) Odishaw article on the International Geophysical Year (May *TST*) is the kind of thing I mean. I hope there can be more of this during a year's publication.

GORDON F. VARS
Plattsburgh, New York

I would not want to miss any issues of *The Science Teacher* or the pamphlets. The latter I put on my reading table and it's surprising how the students look forward to seeing them. I glean many helpful hints from *TST*.

EMMA ROOD
Utica, New York

NSTA is by far the best professional organization I have been a member of. You people are doing a great job and I am glad to be a member of the Association. The national convention I attended in Cincinnati two years ago and the National Science Foundation scholarship I had last summer (1956) at Wesleyan have helped me tremendously.

JOHN B. PHILLIPS
Fairfield, Connecticut

Here are some suggestions I would like to make for the magazine and the Association program.

1) More on classroom ideas, projects, and teaching aids and less material by schools of education. 2) More articles on the science gifted student. 3) More on how to *raise salaries;* it seems to me that there must be methods to raise or supplement salaries through industry. 4) A master student project booklet contributed to by top students.

HAROLD WIK
Beaverton, Oregon

I am enclosing my check to continue my membership in the Association for the coming year.

I have thoroughly enjoyed every issue of *The Science Teacher* which I have received. I think you would like to know that I have interested around ten teachers in the magazine for this coming year.

ANNE F. BAREFOOT
Hallsboro, North Carolina

the impact of science ON SOCIETY

By I. BERNARD COHEN

Professor of the History of Science, Harvard University, Cambridge, Massachusetts

This article is the first of two being published in *The Science Teacher,* based on the major address of the same title made by Dr. Cohen at the NSTA 5th National Convention on March 21, 1957 in Cleveland, Ohio. Space limitations prevent a complete reprint of Dr. Cohen's talk. However, it has been revised and condensed into two articles. The second, to be published in a forthcoming issue of *TST,* will deal with certain history-of-science facts discussed by Dr. Cohen at Cleveland.

IT is a curious commentary on our times that in what we call "the age of science," we do not require that an educated man know science. Apparently this was an important requirement only before the modern scientific age began.

I made a computation not long ago to try to find out what percentage of the college curriculum was devoted to science 100 years ago as compared with today. At the present time, in most of our colleges, every graduate is required to take one science course. This is to fulfill what is generally called—and the quotation marks are important—"a science requirement." Apparently it is assumed that one year, one-quarter of a year, or one-fifth of a year, in terms of a student's studies, is sufficient to equip him as a citizen in a world in which science is terribly important.

But 100 years ago, before our scientific age began, it was generally agreed that science was a very important part of everybody's education. I checked three key colleges and discovered that the students there spent about one-quarter of their whole curriculum—not one-sixteenth or one-twentieth, but *one-quarter,* the equivalent of a whole year—studying science. They were not just taking, as they do today, one course in physics, or chemistry, or biology, but *courses* in physics, chemistry, astronomy, and some small part of biology. In addition to that one-quarter of their curriculum in science, they had to study mathematics. The mathematics part of the requirement was exactly the same as what is today the *whole* requirement in science *without* mathematics.

What about the science teaching of 100 years ago? Surely it existed in quantity, as the statistics I have presented would indicate. But what about its quality?

It is hard to judge the quality of science teaching or of any other kind of teaching in a past age. An examination of the textbooks doesn't tell us very much. We don't know whether the teacher insisted that his students memorize that textbook or tried to help them *understand* the subject. We do know, however, that in some cases the science teaching was very, very poor.

There is a famous letter written by Ralph Waldo Emerson to Louis Agassiz, the noted geologist and comparative anatomist. In it Emerson said he was terribly disappointed with the science education he had received when he was a student. He wrote, "I came to learn about nature and what they taught me was algebra."

Those of us who know science know that algebra is a road to nature—that you cannot learn much about the physical universe without the language of mathematics in which to express it. But apparently no one ever told Emerson that there was a goal ahead. For him, therefore, this was simply a dry and technical subject on the manipulation of numbers and the manipulation of letters.

There is one thing we can say about scientific education as it existed 100 years ago: Certainly as far as America is concerned, the scientific education of the 19th century—taken almost as a whole—did not produce great scientists. I am sorry to say that this is a social dictum which we simply have to accept as fact.

There was something about American society in the 19th century, and about American education as part of that society, which was inhibitive of the production of scientific genius. During the great period of the 19th century when there were eminent names in every field of science—Pasteur, Koch, Helmholtz; or, for example, in the more limited field of chemistry, the Germans, Liebig and Wöhler, Berzelius, the Swedish chemist, and Perkin, the young English discoverer of coal-tar dyes—during this period, we search in vain for an American of such standing. We do not find one until, at the very end of the century, he appears in the person of Willard Gibbs, a great scientist indeed.

The Production of Genius

Clearly, the production of genius is a random event. But considering the size of the American population in the 19th century, we should have been able to produce more than one—more than a Gibbs.

We hope that in the 20th century things are better. But the question I would like to put as a special problem is: "Are they?" Is it true that in the 20th century, America has overcome this problem of the 19th century and has produced the great, leading, challenging ideas which have stirred the whole world of science—and of everybody who loves science and is interested in it?

For an answer, let us think, for example, of the great advances in physics. The names that come to mind first are people like Einstein, Bohr, and Rutherford. Obviously, they are not American. When we come up to the present time, we begin to see some very notable American contributions, but contributions that may be linked too closely to the perfection of instruments, the discovery of new effects, the way to produce such things as new chemical elements—but not linked, perhaps, to the generation of great major ideas.

This is where we should consider the consequences of ideas. We accept the fact that ideas have social consequences—that they make an impact on society. But how often do we consider the *practical* effects of this impact?

Maxwell, for example, wrote a series of abstract equations, to which he was led by studying electrical and magnetic phenomena. Out of these equations came an experiment to test them. In Germany, Heinrich Hertz produced electromagnetic waves, and these electromagnetic waves have radically altered our entertainment, our communications, almost all aspects of our life as individuals and the life of the body politic.

We are told that, experimenting in his small garden at Brehn, Gregor Mendel studied peas and discovered the laws of heredity. We know that the application of the principles of genetics which came out of these experiments has vastly improved the production of corn and other vegetable materials—food useful in a world in which the production of food can scarcely keep up with the expanding population.

These, we are told, are the social consequences of ideas.

So they are—and I do not mean to run them down. But I would like to point to other social consequences of ideas.

Let us consider the three great scientific revolutions—three scientific revolutions which had enormous social consequences in terms of ideas.

The first is the revolution which we associate with the names of Copernicus and Galileo, a revolution in which the center of the universe was shifted from the earth to the sun. In this revolution, men were first told that the earth—the solid body on which we all stand, on which our lives are lived—is not fixed in space, but whirling about the sun. Furthermore, men were told, the earth is to be described (and the quotation comes from Copernicus) as "merely another planet."

It produced an enormous shock when the idea was accepted. And it was accepted because Galileo with his telescope discovered that the earth *is* merely another planet; or, if you will, that the other planets are also earths.

Galileo found that Jupiter has moons and is therefore like the earth. He found that the moon has mountains on it and looks like the earth. He found that Venus has phases and so is illuminated by the sun, as the moon is. And he found that the earth shines and illuminates the moon and so appears like Venus and like the moon itself.

These discoveries were terribly disturbing. Men suddenly had to change all their ideas. They sud-

WALTER R. FLEISCHER

A recent Harvard University News Office photograph of Dr. Cohen.

denly had to realize that every preconception they had had of society, of the order in which man lived as a member of social groups, everything in poetry, in art, in literature that was based upon this older concept, had to be changed.

The social consequences were enormous. We all know some of them. We all know of the difficulty that people who advocated these new ideas got into. And the reason was the impact of a new idea on society.

Think of the Darwinian revolution—the revolution which was the second great blow to the pride of man. The Copernican revolution said that man's abode is not a privileged object, unique in all the universe and placed at the center of the universe. Darwin said that man is not really a unique creature among all the organisms we find. Darwin said man is descended from other forms of life and that man has a kinship with animals which had generally been considered to be of such a lower order that man could look down upon them.

We are all aware of the impact this had on society. Those of us who have read recent American history know the impact this idea still has.

The third revolution is one in which not all of us are sure we are dealing with science; rather, perhaps, with something which is becoming a science. I refer to the revolution associated with the name of Sigmund Freud, which implies to us that man's so-called rational acts are not all dictated to him by his reason.

These three revolutions—first, taking man's home and not letting it be unique; second, not recognizing man as a unique creature in the universe; and, third, saying that man's rational ideas are not always the product of his reason—these are all ideas that have had consequences on society. These consequences, it seems to me, are deeply important for us to understand. Because unless we do understand them, we do not realize that when we talk about science and technology and the teaching of science, we are talking about something which affects the lives of all the people around us, by affecting their source, their concepts of society, and their concepts of social action.

Thanks to the revolution of Galileo—and Newton was a part of it, too—people began to write about social physics, about the idea of social forces, social dynamics, and social equilibrium. Then Darwin came along, and the ideas of society were couched in evolution and the evolutions of society and we even had books called the evolution of the novel. Now, when people talk about society, they talk in language which comes from the treatment of people who have disordered minds. We talk about urges and impulses, and some things which agree with the new psychology—and some things which don't.

The point this leads me to, as I look at this whole development of science as part of society, is this, to put it in its simplest terms: *science is important;* and it is important for society, if modern society is to continue, *that we have scientists.*

But more than skills is required. We need *ideas.* We need to produce people who will be attracted to science and who will get, in the formative years in their secondary school training, something that will let them become great scientists, *idea*-producing scientists, and continue this main stream of development to which America has contributed so little, and to which America owes so much. This, I would say, is a social obligation.

How to do it? I have no panaceas and I have no prescriptions. But I would like to make two suggestions. These are suggestions based on my experience as a college teacher, on experience in teaching individuals who will become secondary school teachers, and on experience in teaching scientists.

I have discovered that one of the things our scientists do not learn—and this is just as true in

(Continued on page 240)

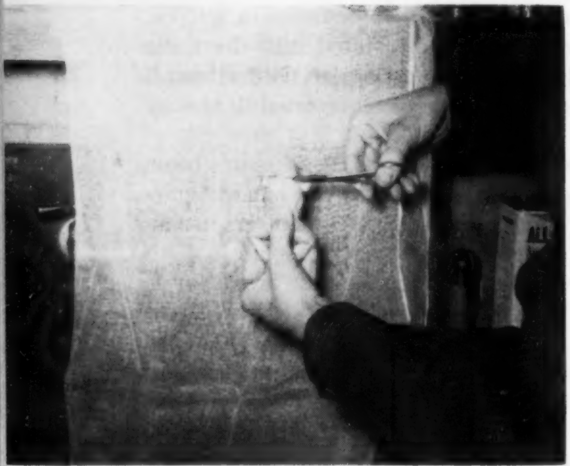


Figure 1. First cut is made

SUCCESSIVE OSMOSIS

By WILLIAM M. SMITH

Thomas Carr Howe High School, Indianapolis, Indiana

Figure 2. Skin is removed

Figure 3. Frog skin removed

This report on a demonstration was a medallion winning entry in the 1956-1957 Science Teacher Achievement Recognition (STAR) awards program conducted by the National Science Teachers Association under a grant from the National Cancer Institute.

ONE OF THE IMPORTANT FUNCTIONS of roots of plants is to obtain soil moisture and mineral salts in solution, and to transfer them from cell to cell by successive osmosis until they reach the vascular system of the plant.

Usually a sketch of these cells from root hair to xylem with arrows showing the direction of movement of these liquids is thought to be sufficient.

This demonstration of successive osmosis enables the pupil to observe vividly this phenomenon as it takes place.

Materials required

Beaker	Rubber bands
Ring stand	Glass tubing
Small funnels	Frog skins
Clamps	Syrup and water

NOTE: The number of funnels, supports, and frog skins will be determined by the number of cells you desire to demonstrate. For this demonstration we will use two funnels and three frog skins.

Procedure

(a) Preparation of membranes. Select the number of frogs desired in order to obtain the number of skins needed for your demonstration. Preserved or fresh skins may be used for this purpose.

As demonstrated in Figure 1, cut through the skin and continue to cut a ring around the frog's body

Figure 4. Attachment of membrane to funnel

just below the pectoral girdle. Peel the skin down by turning it inside out as shown in Figure 2.

Make a cut at the anal opening in order to keep from tearing the skin at this location. Continue to remove the skin from the legs and feet as shown in Figure 3.

Tie off the openings at the anus and at both legs securely with rubber bands and then turn the membrane right side out. Now attach the membrane securely to the stem of the funnel with another rubber band.

The attachment of the membrane to the funnel and the membrane filled with fluid are shown in Figures 4 and 5.

Follow this same procedure with as many funnels as desired and attach the top skin to a hollow bent glass tube (see Figure 6) that has been drawn to a small tip at the top end.

(b) Preparation of solutions. A mixture of syrup and water of graduated concentrations was used to fill the membranes.

For this demonstration a 50 per cent syrup and 50 per cent water solution was used to fill the top membrane. Since the top membrane was attached to a long bent glass tube, a rubber bulb was used to fill the membrane and tube. Squeeze all the air out of the membrane, fill the rubber bulb with the fluid and place it over the drawn glass tip of the

Figure 6. Setup of demonstration

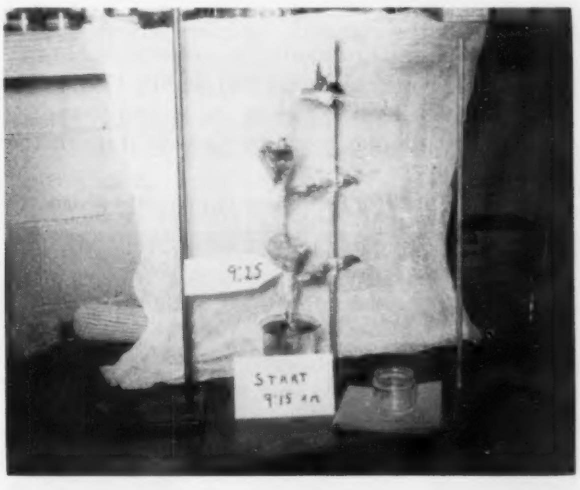
tube and force the liquid into the tube and membrane.

Again force out all the air by pressing on the membrane and continue with the bulb until the membrane and glass tube are full of fluid.

In the second membrane from the top a solution of 40 per cent syrup and 60 per cent water was used. Fill the membrane and neck of the funnel

Figure 5. Membrane filled with fluid

Figure 7. Solution starts moving up



with this solution. Remove all air by pressing on the membrane.

In the third membrane a solution of 30 per cent syrup and 70 per cent water was used and the procedure was the same as that described above. If more membranes are used, graduate the concentrations of the solutions from top to bottom.

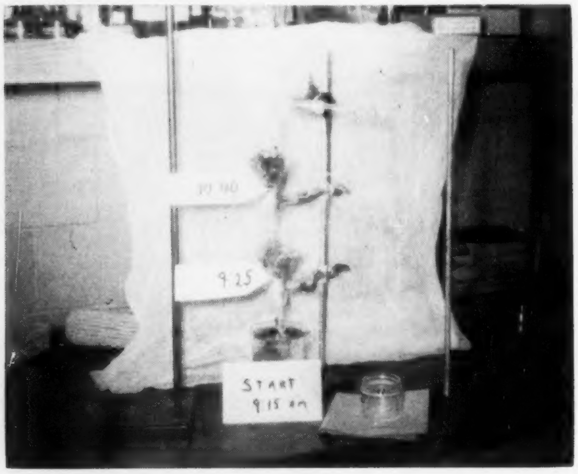


Figure 8. Position of fluid after 35 minutes

(c) Setup of demonstration. Suspend the bottom membrane in a beaker of water. Rest the middle membrane above this one in the bottom funnel and place the top membrane in the top funnel and support all with ring stand clamps as shown in Figure 6.

The solution, as it drops from the tube at the top, may be collected in a test tube supported by a clamp to the ring stand, or may be collected in a beaker placed on the table.

Observations

In ten minutes the solution from the bottom membrane will start to move up into the funnel and as time passes the funnel will gradually fill with the solution.

As this liquid surrounds the second membrane, successive osmosis will start and within 35 minutes the liquid will begin to rise in the second funnel.

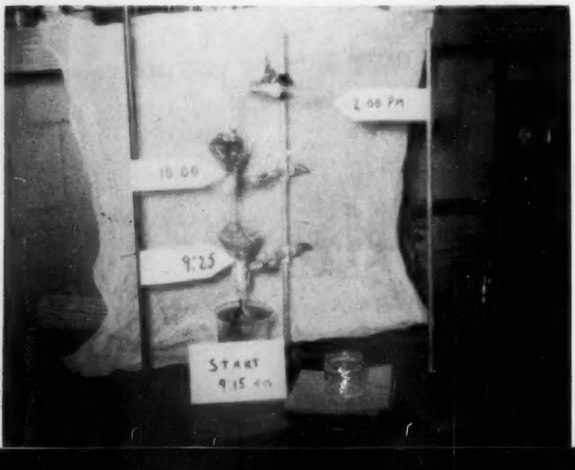
Finally the liquids move by osmosis through the third membrane and the fluid starts to drop from the end of the glass tube. This will take a little more time; the drops will start in from three to four hours.

This dropping will continue for periods longer than 24 hours, depending on the volume of the solutions held in each membrane.

Summary

1. Following this procedure you will have an effective method of demonstrating successive osmosis.
2. This laboratory demonstration may be prepared by the teacher or assigned to an interested pupil.
3. Other types of membranes may be used; egg membranes and pig bladder sections have been used for this demonstration.
4. Most of the items of equipment can be improvised if not available.
5. Stain may be added to the solution to observe more clearly the liquids as they move from cell to cell.

Figure 9. Dropping starts about four hours from start



NSTA Specialist for Elementary Science

Dorothy E. Alfke, Associate Professor of Education at Pennsylvania State University, University Park, has joined the NSTA staff as its Specialist for Elementary Science. This is a new staff position which was created as a key step in the Association's program to expand its services for the elementary school teacher. (See page 235.)

Serving on a part-time basis, Dr. Alfke will continue in her teaching post at Pennsylvania State University and will carry on her NSTA activities from there. She will act as a consultant on NSTA elementary science projects and will help edit the expanded *Elementary School Science Bulletin* and advise on elementary science articles for *The Science Teacher.*

The new staff member received her B.S., M.S., and Ph.D. degrees from Cornell University at Ithaca, New York. The subject of her doctorate was elementary science and nature education. Prior to joining the faculty at Pennsylvania State University, she was an instructor in science education at Oneonta State Teachers College in New York and a mathematics and science teacher in Bridgehampton and Guilford, New York.

SOME WHY'S OF CONSERVATION

By ELIZABETH HONE

Research Assistant, The Conservation Foundation, New York City (on leave as Assistant Professor of Education, Los Angeles, California, State College)

CONSERVATION is a word that a great many of us are familiar with—but not many know exactly what its practice involves.

Considering what the public schools can do to determine how conservation can be furthered, the Conservation Foundation has been making a study with two points in mind. These are, firstly, that the schools help to shape the thinking and attitudes of the future adult population; secondly, that the schools at the same time reflect the thinking and attitudes of the present adult population. The school curriculum is the blueprint for transmitting values, understandings, and skills. The Foundation study was designed to determine how schools are channeling the values, understandings, and skills necessary to conserve our resources.

For the past eight months, the Foundation has been making an analysis of what is being taught about conservation on a nationwide basis from kindergarten through grade 12. Curriculum materials are already on hand from major cities which together enroll about one-sixth of the total U. S. school population. We also have a sampling of curriculums from county districts and state conservation and/or education departments and colleges.

A preliminary analysis of this collection indicates conservation is studied on all grade levels. Conservation tends to be taught more often as part of science and/or social studies than as a separate subject in any one year of school.

In the curriculums we have studied, the topic, Natural Resources, is generally treated as follows:

A. Renewable: soil, water, plants, animals
B. Non-renewable: metals, minerals, fossil fuels
C. Human Resources: "anyone who contributes to the development of a natural resource through invention, discovery or substitution." (Paul Brandwein)

There is general agreement as to what is meant by *renewable resources* and *non-renewable*. But where *human resources* are included, we find a wide variety of interpretations or definitions. We find, too, eight times more emphasis on *renewable resources* than on the other two categories.

Consider, however, that nearly 60 per cent of our population now live in metropolitan areas. The indications are that this percentage will increase. Metropolitan residents are daily confronted with problems involving human resources, and to a less extent, non-renewable. They are confronted, in general, only indirectly with problems involving renewable resources. City dwellers need to know how to behave and vote intelligently about renewable resources, but in a different way than if they were living in the country. In an already overloaded curriculum in metropolitan schools, conservation education is not truly justified if it deals with problems which children see only in camp or on summer vacation trips to the national parks (assuming they go to camp or on trips).

Those of us who are dedicated to the notion that "conservation is everybody's business" need to take a hard look at the environment in which nearly two-thirds of our children go to school; namely, the metropolitan environment. We must develop a kind of conservation education which can be demonstrated and practiced in the environment the child sees every day. Every child, whether he lives in the city or country, can *do something* which we recognize as conservation.

For example, water is rapidly becoming one of our most critical natural resources. Every child can learn why it is important to use water but not waste it. He can learn that water just doesn't come out of the tap. He can learn that many people have worked hard to collect the water he drinks and to keep it very clean for him and his family and neighbors. He can learn that all of this costs a great deal of money. He can learn why we are wasting our own money if we waste water. He can learn, from some simple scientific experiments, about the source of water and the never-ending cycle of evaporation and condensation which replenishes it.

Good housekeeping of school supplies, saving time and energy by group planning, saving fuel, and being more comfortable because of more scientific room ventilation—these are some of the conservation activities teachers practice. A few school curriculums, notably some at the primary level, are beginning to include conservation as an attitude, a way of behaving toward the environment. Teachers

(Continued on page 230)

COLLEGE LEVEL CHEMISTRY FOR GIFTED HIGH SCHOOL STUDENTS

By DONALD B. SUMMERS
Columbia High School, Maplewood, New Jersey

As a science teacher with a background as a research chemist in industry, the author of this article welcomed the opportunity to be one of the pilot teachers in the Advanced Placement Program. Sponsored by the College Entrance Examination Board, the program was designed to be flexible and exploratory. It begins in the schools with the establishment of college level courses as a link between schools and colleges. The individual schools taking part in the program select the subject matter of the courses they establish. One of the features of this expanding program is an annual subject matter conference held at various colleges and schools throughout the country late in June; at these sessions, the school and college teachers discuss their mutual problems.

DURING the fall of 1954, Columbia High School of the South Orange-Maplewood School District in New Jersey was asked to be one of the test schools in the Advanced Placement Program which originated in the School and College Study of Admission with Advanced Standing. The author was selected as the teacher for college level chemistry. Several immediate questions came to mind: "Can I do it? What do I teach? Where do I start?" It has been 25 years since the author taught in college and 20 years since he was a research and development chemist. This lack of recent firsthand contact with the subject was quite a hazard. Even worse, there had been little time for a busy high school teacher to keep up to date with new developments and theories in chemistry.

The first step in course design was to send letters to the chemistry department heads of colleges participating in the Advanced Placement Program and to friends who were teaching in colleges, requesting information as to course content, texts used, laboratory manuals, and suggestions for a small chemical library. Not only was the requested information sent but a great deal of advice pertaining to possible future trouble areas was also given.

Sample copies of about 30 different college textbooks and laboratory manuals were then obtained. Careful review of these suggested six as most likely to be satisfactory for the students who would make up the first class. Ten of the best "A" students in the college preparatory chemistry class were asked to rate these books, designating the one they would like to use if they were to take the proposed course.

The textbook receiving the highest average score (and the one we decided to use) was *General Chemistry* by Sisler, Vander Werf, and Davidson (1). The other books examined are listed in the bibliography (2) (3) (4) (5) (6). The laboratory manual to be used was selected by the instructor without student opinion; namely, *College Chemistry in the Laboratory, No. 2* by Malm and Frantz (7). Additional helpful preparation consisted of several trips by the instructor to participating secondary schools and to colleges for information, observation, and help.

In due time it became necessary to estimate the probable cost of additional equipment and materials necessary for the course. A request for funds was sent to the Board of Education and the program was very nearly stopped at this point. Administrators seem to have little conception of the cost of scientific materials. The first reply was a flat refusal; then the administration suggested that the laboratory work could be described or read from a book and these "gifted students" would obtain all the experience necessary.

Considerable time, effort, and a careful argument on the value of laboratory work finally produced a request to pare the expenses to "the absolute minimum." Many hours went into a thorough study of the laboratory work to be included. Some experiments could be varied; some apparatus could be improvised; certain experiments could be omitted.

A pared request was sent in. Two-thirds of this amount was granted. Even so, we decided to go ahead with the course.

The ten "A" students who selected the textbook were prevailed upon to try the May 1955 examination for Advanced Placement. This was done to determine our school's present level of instruction, and it was hoped that when the college course was

given, a definite difference could be noted. (The difference between high school chemistry and college chemistry has been very well summarized by Norton (8). At the Oberlin College Conference (9) involving interested college professors and secondary school teachers of chemistry who are carrying out the program or would like information about the program, it was learned that all nine of our students who took the examination received grades of "one" (failure), as was expected. Clearly, our college preparatory chemistry course did not in any way approach a college level course.

All during the summer of 1955, plans were made for lectures, problems, examinations, and experiments. Classes started in September with no stenographic or other clerical help provided. But we did have a student assistant—one who had not studied chemistry. This student could help arrange and put away equipment and make up some solutions when concentrations were not critical, but he was limited to one hour of work per day by Board of Education policy. During 1955-56 with nothing really organized by actual experience, the instructor spent about three hours per day for laboratory preparation alone.

During the spring of 1955, the class guides (advisors) of the junior class (next fall's seniors) started selection of the students for the Advanced Placement Program. The following criteria were used:

1. A past record of academic excellence, particularly in mathematics and sciences.
2. A high intelligence quotient (the first class varied from about 135 to 165).
3. The recommendation of the student's former mathematics and science teachers.
4. A record of emotional stability and maturity.
5. The student must have chosen the course of his own volition.
6. Parental permission must be obtained.
7. Have a personal interview with the instructor.
8. Second year algebra was required and, although physics was not required, it was strongly recommended. (Four of the first class had no physics.)

It will be noted that these criteria are very similar to those stated by Geffner (10).

The class started with 19 students, 16 boys and three girls, none of whom had studied chemistry previously. Within two weeks, one boy dropped back to the standard high school course, "because this course is too hard and I don't want to work so hard." Another boy entered from standard chemistry after two weeks, "because I find I like

The student in the foreground is determining the production of electric current by means of oxidation-reduction actions.

chemistry, find it easy, and want to make it my life work." This boy also added, "Besides, I like the extra laboratory work that the college class does that we don't do." The class also ended the year with 19 students.

A series of mimeographed sheets of a "Course of Study" was given each student on which was listed the material for which he would be held accountable. After each main heading was listed the chapters in the textbook in which the material could be found. Herewith is an abridged version of the Columbia High School Course of Study for College Level Chemistry. (A more detailed outline will be sent on request to those interested.)

I.	General Terminology
II.	The States of Matter
III.	The Atomic Theory
IV.	The Structure of the Atom
V.	Chemical Calculations
VI.	Some Common Elements
VII.	Oxidation-Reduction Actions
VIII.	Thermochemistry
IX.	Water and Solution
X.	Electrolytes
XI.	Equilibria
XII.	Nitrogen, the Atmosphere, and the Nitrogen Family
XIII.	The Halogens
XIV.	Electrochemistry
XV.	The Sulfur Family
XVI.	Metals in General
XVII.	The Transition Elements
XVIII.	Organic Chemistry
XIX.	Colloids
XX.	The Active Metals
XXI.	The Light Metals
XXII.	Silicon, Boron, and Related Elements

The interest of the students in the chemistry course is evident in this photograph taken during a lecture period.

During the first year we did not cover units XXI and XXII and, because of the early date of the Advanced Placements tests, units XVIII, XIX, and XX were discussed in a sketchy manner. During this second year, we hope to go into more depth in units XVIII, XIX, and XX. The last two units are used as a buffer for the time after the placement tests and before the closing of our school during the latter part of June.

Our weekly class schedule included: two 50-minute lecture periods, two double laboratory periods of 103 minutes each with extra laboratory time available after school if needed, and one discussion and/or test period of 50 minutes. The latter period was used about every third week for test purposes, and almost every week for a series of problems or questions to emphasize certain phases of the work. These problems or questions formed the basis of our discussions and quite frequently involved the use of outside literature as provided by the school library and certain personal books provided by the instructor. (A list of the books available for our students will be sent, on request, with the course outline.)

Two comprehensive examinations were given during the year, one at mid-year and one at the end of the course. Typical questions taken from these examinations are as follows:

I. Give good theoretical explanations of the follow-lowing:
   A. When alpha particles are sent through gold foil, nearly all proceed in a straight line, a few are deflected, and about one in every 8000 is reflected backward toward the source.
   B. There is a sharp rise between the first and second ionization potentials of aluminum and a still sharper rise between the third and fourth ionization potentials.

II. A. A solution contains 10 g. of acetic acid (CH_3COOH) in 125 ml. of water. What is the concentration of the solution expressed as (1) mole fractions of CH_3CHOOH and of H_2O; (2) as molality?
   B. The vapor pressure of pure water is 25.2 mm. of mercury. What is the vapor pressure of a solution which contains 20 g. of glucose ($C_6H_{12}O_6$) in 7 g. of H_2O?

III. A. What volume of chlorine at 22° C and 770 mm. of mercury could be produced by passing 1500 amp. through a salt solution for one hour?
   B. Give the oxidation state of sulfur and show by use of dots for electrons, the structural relations of:
   (1) SO_2 (2) S_8 (3) $S^{=}$ (4) HSO_4^- (5) H_2S.

No definite assignments were given except certain deadline dates for problems and for examinations covering a definite phase of the work. A suggested schedule for completion of laboratory work was posted. Careful scheduling of the use of three triple-beam balances, accurate to .01 g., and two analytical balances, accurate to .001 g. was necessary for efficient use of laboratory time. Use of our three centrifuges also had to be carefully arranged.

The Week-end Load

Paper correction and teacher preparation took three to four hours a day, five days a week, and five or six hours on Saturday and Sunday. Very little, if any, recognition or time compensation for this was given by the administration. Teaching load included a homeroom, two standard college preparatory chemistry classes meeting six periods per week each, study hall supervision of about 200 students, and supervision of the Chemistry Club. In addition, certain night duties were mandatory, such as PTA meetings, supervision during dramatic performances, and graduation ceremony. This year, 1956-57, differs only in that now there is a third standard college preparatory class instead of the study hall. Stock solutions of most materials have been prepared and one year of experience lies behind.

As the first year proceeded, the students, after the first shock of a college examination, were eager, alert, and inquisitive. Previously, in their school careers, it had not been necessary for them to spend too much time preparing for their classes.

Here, for the first time, it was necessary to study —something they had either forgotten how to do or never had to do. A survey indicated they were spending from six to 12 hours per week on chemistry outside of the regular class and laboratory periods.

They were seldom absent, indicating their excellent health, and they were tall, attractive, and well built. Their extracurricular activities were many and varied. Contrary to the general impression that children with high mental abilities are "queer," overcompensated in one ability and therefore poor in athletic and other ability, and physically small or unhealthy, these students seemed to be superior in all phases of school life as well as community life. There was, however, one set of circumstances that bothered most of them; namely, that some colleges would not accept the course or, in a few cases, would give advanced standing only upon passing their particular examination in the fall. So far as is known at present, only one college has refused to honor a satisfactory grade in this advanced course.

All 19 students were urged to take the advanced placement examinations but only 13 finally did so. The results of these tests were as follows:

GRADE	PART I	PART II
5 (High honors)	3	3
4 (Honors)	6	4
3 (Creditable)	3	4
2 (Passing)	0	1
1 (Failure)	1	1

In the laboratory: The girl student is determining the equivalent weight of a solid acid.

No student failed both parts. The student who received the "1" in Part I obtained "3" in Part II, and the student who received a "1" in Part II obtained a "3" in Part I. These grades show definite improvement over the group of ten the year before with whom no attempt had been made to teach "college" chemistry. Thus we felt that the first "experiment" had been satisfactory. Future years, however, will tell a more conclusive story one way or another.

Questions . . . and Answers

At the end of the year, certain questions were asked each student as to his feelings and criticisms of the course. Representative questions and answers are summarized as follows.

1. All felt that two years of algebra and physics should be prerequisites.
2. Half or more felt that solid geometry and trigonometry were helpful—10, 13/19.
3. Most felt that the time allotted for lectures and for written work was sufficient—17, 18/19.
4. Half felt that the time allotted for laboratory work was sufficient—10/19.
5. Few felt that the time allotted for discussion was sufficient—3/19.
6. Most felt that atomic structure, chemical calculations, and thermochemistry were the easiest areas, and equilibria, electrolytes, and electrochemistry the most difficult areas, in the orders listed.
7. All felt that the course was of great value. The question was, "Do you think that this type of course is of value in the high school?" The answers all came back, "Yes!" heavily underlined, or "Definitely yes!"

Several specific suggestions have been incorporated in the teaching of the course this year; namely: following the general order of the textbook; correlating lecture work with laboratory work (difficult for the instructor and not too well done!); and allowing more time for discussion.

What happened to the 19 "guinea pigs"? They went to these colleges as follows: two to Yale University, one to Princeton University, one to Drew University, one to the University of Delaware, one to Wesleyan University, one to Antioch College, one to Swarthmore College, one to Oberlin College, one to Haverford College, two to Wellesley College, one to Williams College, one to Massachusetts Institute of Technology, one to Rutgers University, one to Johns Hopkins University, one to Cornell University, one to Pennsylvania State University, and one to Newark College of Engineering.

On the 13 who took the advanced placement

examination, the following data have been obtained:

Number exempt from freshman chemistry	9
Number not exempt from freshman chemistry	4*
Number taking advanced chemistry	6
Number taking no advanced chemistry	5
Number repeating freshman chemistry of their own volition	2
Number receiving graduation credit from college	4

Of the six students who did not take the advanced placement examination, all are repeating freshman chemistry and have reported that they are having very little, if any, trouble with the course; and all are receiving good to excellent grades.

It is the hope of the writer that this report may be of value to those who are contemplating such a course and perhaps give an insight to some colleges and industries into the problems besetting the secondary public school teacher.

There are some suggestions that could be made to schools, colleges, and industry whether they are already involved in the Advanced Placement Program or feel that they are interested in becoming involved.

1. The instructor who is to handle the course, needless to say, should be well grounded in the varied fields of chemistry; he should be *intensely interested* in seeing that the course is a success; and he must be willing to put in time and effort that, a good many times, seems utterly impossible.
2. The Boards of Education and administrators must be willing to appropriate funds far above the normal per-pupil cost and to provide the teacher with, as it seems to them, a ridiculously low teacher load. Help should be provided, also, in the form of a responsible adult for stockroom and laboratory assistance. Clerical help is a definite necessity.
3. Publicity in the school and community would help provide a favorable "climate" in which to operate. It would inform the students, parents, and general public of the type of program, its hopes and aspirations, and the past success of the program.
4. Colleges should give unbiased preference to the acceptance of the successful student. And once accepting the student, the college should provide further demanding work. Nothing will destroy the initiative of these students faster than forcing them to repeat a lesson already well learned. It is the author's belief that any student with a satisfactory grade in secondary school should not be permitted to repeat the course.
5. Industry might provide equipment, material, and funds for use by the schools in this program. Equipment that might be donated could be discontinued models, apparatus of slightly less accurate character than that desired by industry, or model-types which are being replaced by a more modern type; material could be of the type used in great abundance by a particular industry; funds could be provided for use of extra personnel to offset the time needed by the teachers of these college courses, or scholarships provided for the further education of these top students; and reference books could be donated to the school libraries or science departments of the schools concerned.

For the author, the experience has been a harrowing one, which is continuing to a lesser extent, but an experience of great personal satisfaction. It is a pleasure to see the future leaders in science develop under one's own eyes; to learn and re-learn with them the up-to-date theories, processes, and methods; to know that at least in one's own small way, one is at last making a contribution to the needs of our country; and to take part in giving a new meaning to the life of our forgotten youngsters . . . "the gifted student."

* One college would not recognize a score of two "fives" on the advanced placement examination. The student is not taking any chemistry course. One student failed a special examination provided by the college after securing two "fours" on the advanced placement test. Two students are repeating the course of their own volition, and did not apply for advanced placement.

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Let's Join the Science Fair Winners

By MAITLAND P. SIMMONS

Irvington, New Jersey, High School

This and the following article, *The World of the Honeybee,* present in juxtaposition the Here's How To Do It and Here's How It Has Been Done principles. With October designated as National Science Youth Month, now is the time to start science fair activities.

MORE AND MORE SCIENCE TEACHERS of our secondary schools are asking, "How can we produce more science fair winners?"

Some of the answers may seem routine, but a review of these and others can stimulate a successful program if taken into account together. For example, since science fairs generally occur near the end of the school year, it would appear that the first phase of the problem would be to encourage and inspire student and community interest early in September and continue doing so throughout the year. This may be partially accomplished by having the potential young scientists demonstrate their organized projects of the previous year at Kiwanis and Lions Club luncheons, over television, and at the school assembly. In some instances, students have been invited to exhibit them at libraries, museums, and science organizations.

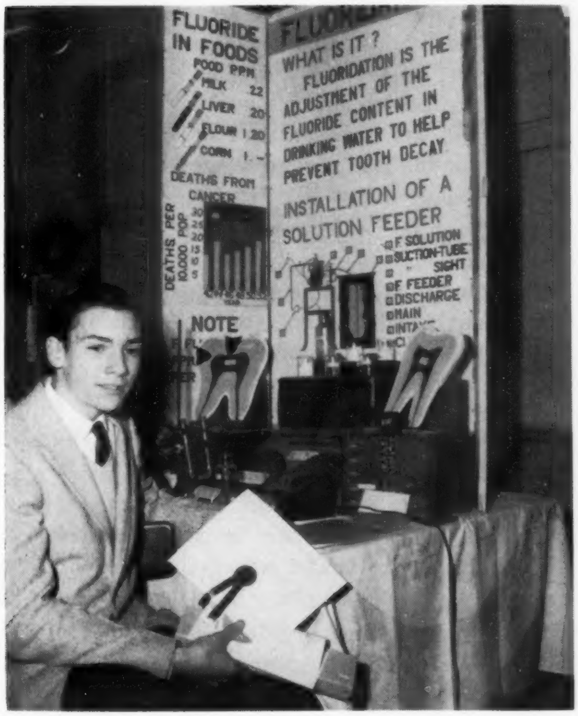
As a further encouragement and stimulation, the student body should be given an opportunity to view these realistic, interest-centered projects in the front lobby of the school or at some convenient place. Pupils will gain many ideas from seeing these and other well-made exhibits at science fairs, hobby shops, industrial plants or offices, and department stores. Local newspapers, school bulletins, and professional journals can do much in the way of motivation by publicizing science projects and fairs. Moreover, write-ups of previous well-presented exhibits with student pictures along with their posters serve as valuable helps for the creation of new recognition projects. In this way the student becomes more aware of what he has to achieve.

Other incentives include such awards as scientific equipment, science books, yearly subscriptions to science magazines, U. S. Savings Bonds, checks, engraved medallions, bronze plaques, gold keys, and certificates of excellence. In many instances, the top honors often lead to full-time tuition scholarships.

The second step is to carefully screen the interested science-minded students with high academic records and recognized capacities, particularly in the areas of science and engineering. However, these students with high-level abilities are not always reliable. For example, one of my boys with a superior I. Q. of 137 and excellent in art fell apart when it came to stiff competition. In contrast, another adolescent with an average intelligence, 107 I. Q., received five awards, an honorable mention, a fourth, a third, and two firsts from three projects in three years running at various fairs. Sometimes

Ronald Roman, Irvington High School, proudly displays his fluoridation project, a first-prize winner, at the fourth annual Greater Newark Science Fair in the Newark College of Engineering.

NEWARK COLLEGE OF ENGINEERING



ROSS PHOTO SERVICE

Anthony De Santis, Irvington High School, points to his solar battery exhibit, a first-prize winner, at the North Jersey Science and Mathematics Fair in Fairleigh Dickinson University.

a teacher will discover a gifted youngster who has been working on some special hobby over the years and wishes to continue with that as a project.

For national competition, recruit tenth- and 11th-grade students with leadership, citizenship, good attendance records and reading scores, special abilities in writing, freehand and mechanical drawing, a high degree of manual dexterity, and above all, strong in the sciences and mathematics. Other contributing factors for success include willingness to spend extra time, to attempt difficult tasks, and to face failure. Many seniors are likely to be too busy in other school enrichment activities, together with planning their college careers. Furthermore, it is desirable that these young people come from homes of at least moderate circumstances as money is needed for materials and construction tools, including a car to transport their interest-creating projects to the science fairs. In some cases, Boards of Education furnish the transportation.

The outcome will be more satisfactory if these persistent students are in your classes, since you are in a position to continually prod them and to discuss their pertinent problems. Moreover, to hold these students' interest after they leave you for the next upper grade, organize a special science project club. Frequent after-school hour conferences are then necessary. Bulletins can suggest the time and place.

After the identification comes the selection of subject matter geared to the students' comprehension. Consider timely areas such as electronics, automation, atomic energy, supersonics, and the International Geophysical Year. From the cumulative evidence, there appears to be many more quality entries in this physics field. Chemistry seems to be less competitive. However, if possible, allow the youngster to make his own choice. To be realistic and meaningful, projects should have a personal interest origin. Recent publications of local, state, and national science societies are excellent media for getting topics and ideas, including dates and locations of fairs.

We are now ready to embark on most extensive coordinated research which involves a vast collection of factual information from professional libraries, museums, and industries along with continued correspondence with them. On some occasions, conferences and laboratory visits with trained personnel are a "must" for supplementing the acquired knowledge. All pertinent material should be classified and assembled in an attractive folder marked "Classification of Data."

Construction plans follow, and from these the out-of-school project is ready to be set up. Avoid models, especially the nonoperating variety, as they are less likely to be top winners. Furthermore, make certain all parts are obtainable and not too costly; better still are those which can be made. If possible, try to get assistance in the form of conference and laboratory equipment, particularly from science-related industries and learned societies. For transportation, the well-planned project should be compact, light but durable, and in sections that can be easily assembled. If electrical switches are used, make sure they are completely enclosed. The display should be operative with clear, easy-to-follow instructions, parts neatly labeled, and a colorful explanatory poster approximately three feet high, simple, and attractive with the significant ideas standing out. The standard size for competitive exhibits is four feet wide by three feet deep.

Along with the project, the student should present a typed manuscript—on good quality $8\frac{1}{2}$ by 11-inch white paper, double-spaced, and on one side with wide margins. This report should include Recognition of the Problem, Formulation of the Problem, Method and Procedure, Findings, Evaluation of Data, Recommendations, Sources of Data, and Selected References. To insure clarity in setting forth ideas, advise students to use short sentences and short paragraphs. Misspellings, sloppy erasures, and illegible pen or pencil corrections should be avoided. The writer should compile a Table of Contents, number the pages in sequence, and, when necessary, include lists of illustrations and tables in black India ink. A carbon copy should always be kept. The report should be placed in an

attractive folder marked "Interpretation of Data." Students should try to integrate these reports with work in their English classes.

To follow up the true progress of the student's cooperative undertaking requires several visits to each home, especially as the worth-while projects near completion. These friendly periodic conferences should furnish an understanding foundation for the completion of the work. Students and parents should invite qualified people to their homes for suggestions and improvements. The teacher-sponsored experience should show social values of living, problem solving, originality and creativity, understanding of scientific principles, critical and independent thinking, artistic expression, and thoroughness. Make sure the well-developed projects are finished in advance of the deadline and that the application entry blanks have been mailed to the science fair committee.

At the opening of the science fairs, these future scientists should arrive early to allow ample time for setting up the exhibit attractively, getting a proper location, and obtaining last minute tips from other exhibitors. These projects should have been packed with utmost care, protected from the rain, and accompanied by a tool kit for repairs. For the judging period and the public, exhibitors must be available for questions, explanations, and operations. All valuable accessories should be guarded.

Along with planning for the fair, the students should be encouraged to submit for publication condensed investigations of their scholarly projects and 8 by 10-inch clear glossy prints with captions to student papers, such as *Tomorrow's Scientists*, National Science Teachers Association, 1201 16th Street, N. W., Washington 6, D. C. As a further incentive for national recognition, they should also send 1000-word reports with clear glossy prints of their projects to the Future Scientists of America Foundation for its annual program of Science Achievement Awards for Students at the same NSTA address, and to the Westinghouse Science Talent Search, Science Clubs of America, 1719 N Street, N. W., Washington 6, D. C.

From these creative activities, the budding scientists acquire at least an insight into the habit of analytical and critical thinking. Equally important, they emerge from these expanding experiences with a prevailing attitude of faith in the school as a strong source of assistance.

The World of the Honeybee

By CHARLES E. PETERS

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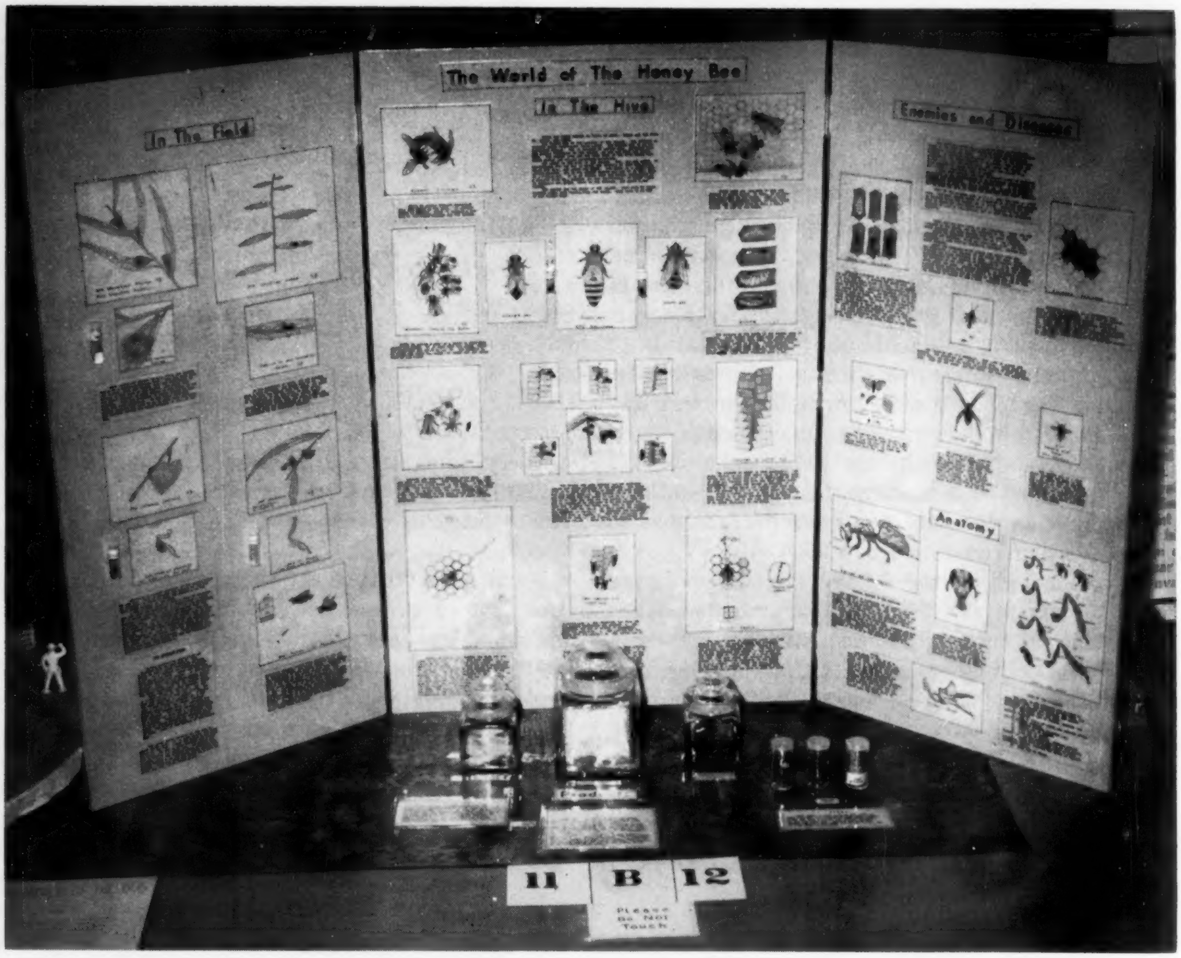
Although only two years old, the Santa Barbara (California) Intra-School Science Fair has already become a community project. It is financed by the Santa Barbara Foundation and the contributing sponsors include the Rotary Club, Santa Barbara Recreation Commission, Santa Barbara County Board of Supervisors, Santa Barbara City Schools, Santa Barbara Catholic High School, Laguna Blanca, and various PTA organizations in the city.

This is the story of one of the projects entered in the Santa Barbara fair last March and of the research and work that went into it.

JOHN WATERS (a senior at Santa Barbara High School last winter) started keeping bees in the ninth grade. He purchased a wire package of bees which contained one queen and two pounds of worker bees. The bees in this package were a pure strain—Italian, one of the most popular races of bees in America. They flourished during the first season, although much of the weather was foggy. In the spring his hive astounded him by storing more than 250 pounds of honey.

The bees "swarmed" on the first day of spring. This is truly an amazing sight—thousands of airborne insects stirring the air in frenzied flight. During a swarm, John was surprised to find that he could stand in the center without being stung. The swarm flew to a branch of bamboo some 40 feet in the air and remained there throughout most of the day, while John frantically tried everything from ropes to water to bring them down. When the sun was low, the whole swarm departed with a loud high-pitched hum. These bees were free to reside wherever they desired, and they chose a chimney of an old house down the street.

John has had no trouble in losing swarms since then. He presently has ten hives; six at his house



This photograph of John Waters' project gives graphic evidence of the work and research that went into it.

and four in an outapiary, which he tends carefully.

It seemed quite natural that John Waters selected "The World of the Honeybee" as the title of his science fair project. He decided to have five sub-topics to his exhibit: (1) In the Field, (2) In the Hive, (3) Enemies and Diseases, (4) Anatomy, and (5) Products. Each of these sub-topics is discussed briefly as follows:

(1) In the Field (left panel). In the field the workerbees gather nectar, pollen, water, and propolis.[1] The nectar, which is converted into honey by a process about which we know little, is the most widely gathered substance. The pollen, the male sex cell of plants, is gathered abundantly when the bees are raising broods. The water is obtained when little nectar is coming in and is used by the brood.

The purpose of this first section was to show, by drawings, how the substances are gathered by the bees. He drew the bees in situations in which they would be gathering the appropriate product.

(2) In the Hive (center panel). After the four substances mentioned above are gathered in the field, they are brought to the hive to be used. In the hive they are used for myriad purposes. In this section, John illustrates the activities which continue inside the insect multitude. Some of the operations that take place inside the hive are the storage of honey, the brood rearing, colony maintenance, and the guarding of the hive.

The nectar, having been gathered, is stored in the wax cells. During the night, the colony stations "ventilators."[2] The circulating air causes the water to evaporate from the nectar, a dilute sugar solution. After a few hours the honey is sealed

[1] Propolis is a resinous gum collected from many species of plants and used by the bees to seal cracks in the hive, as well as a strengthener of the honey and brood combs.

[2] Ventilators are bees stationed throughout the hive, beating their wings and causing the air to circulate.

over. Some experts believe the ripening process continues after this.

The pollen is used primarily for the brood. The pollen, being extremely rich in protein, is fed to the rapidly growing brood. All insect broods go through complete metamorphosis in 21 days. Since the intense activity of the workers works them to death within a few weeks, the brood rearing is a vital task during the honey-flow.

The hive must be maintained in constant repair. Often the combs are damaged; bees die off at a slow, but constant rate, resulting in the necessity of rebuilding and cleaning.

Often, during the periods of dearth, foreign bees will try to rob honey from a hive. Because each colony has a different odor these robbers are detected, and either chased away or stung to death. The guarding of the hive is a very necessary part of the life of the bee inside the hive.

(3) Enemies and Diseases (upper right panel). This section contains a series of drawings which show various bee diseases and bee enemies. As far as the bee is concerned, this phase is unpleasant. To John, however, it was fascinating. He was forced to destroy a large percentage of his hives, including a cherished, original hive because of American foul brood, the most serious of the brood diseases. Of the two types of diseases—the adult diseases, preying on the adult bees, and the brood diseases, which infect the young brood—the latter is considered to be more serious.

The honeybee has many enemies, although one might think differently after having been stung. Among their enemies are spiders, skunks, bears, and their most hated enemy, the wax moth.

(4) Anatomy (lower right panel). John touched rather lightly on this subject. For this section, he drew a large bee with the organs in different colors, labelling each important organ and telling its purpose.

(5) Products (foreground of panel). The section, in the foreground of the projects, consists of two important products of the honeybee: honey and beeswax. It does not include the most important product, which is, of course, the pollination of plants. A typed card in front of each product describes it more thoroughly.

(6) Observation Hive (a later improvement). Local science fairs are usually held in March, regional science fairs in April, and the National Science Fair in May. This provides the exhibitor three or four valuable weeks in which the project can be improved.

John Waters used this time to develop an original observation hive which replaced "products" in his exhibits. The hive seemed to be a unique invention. He constructed the usual observation hive, except that the observation glass was at a 30-degree angle with the horizontal. This enabled onlookers to see the hive from a standing position, making it easier for observation—its sole purpose. Because the glass was at a 30-degree angle with the horizontal, the bees, accustomed to building their combs downward, had to be taken into account. He tilted the hive so that the glass was perpendicular to the horizontal. He waited until the bees built a comb, then placed the hive in the original position.

In this project, as in thousands of boys' and girls' projects being constructed for science fairs throughout the nation, the exhibitor is gaining the experience of planning and executing a science project akin to the work of professional scientists.

WHAT TO DO ABOUT ASIATIC FLU . . .

Gearing its activities to the possibility of an "Asiatic flu" sweep of the United States this fall or winter, the U. S. Public Health Service has been operating on the "ounce of prevention" theory. By mid-August, vaccine manufacturers had ready for delivery more than 500,000 doses of a specially developed Asiatic flu vaccine to help protect servicemen and civilians against the feared spread of the disease.

Originating in the Far East late last spring, this particular type of influenza has caused misery but comparatively few fatalities. The virus was isolated by the U. S. Army and by May 22, the Public Health Service had sent prototypes of the Asian strain to licensed influenza manufacturers. Surgeon General Leroy E. Burney is frank about the potentialities of an epidemic in the United States later this year. He says, "There will not be time enough, of course, to produce and administer sufficient vaccine to immunize the majority of the population before the influenza season. But the vaccine is the only known preventive and we want to make the best use of it we can."

The specially developed vaccine is a monovalent or one-strain type. More will be released for public use as soon as it becomes available. The advice of the Public Health Service is for civilians to consult their own physicians and, if vaccine is available, get an inoculation. Nothing to panic about, the Public Health Service says, but if the proverbial ounce of prevention can prevent a pound of cure, why risk being ill?

The Commission on Education in the Basic Sciences

A report by Commission Chairman John S. Richardson, NSTA Retiring President, Professor of Education, The Ohio State University, Columbus. Details about the commission and its membership were given in the April issue of *The Science Teacher* in the column "NSTA Activities," page 141. The group met in Washington in May and in June.

THE need for an action arm of the National Science Teachers Association to concern itself with some of the fundamental problems of science teaching has been clearly demonstrated as a result of the two meetings which the Commission on Education in the Basic Sciences has already held. While the commission is not conceived as an action body in itself, it has as its major function the stimulation and support of developments that will contribute substantially to the improvement of science teaching. Clearly any such proposals for study and action will fall within the approved policy of the Association.

Initial discussions presented and led by Professor S. Ralph Powers, Emeritus of Teachers College, Columbia University, and Dr. William G. Pollard, Director of the Oak Ridge Institute of Nuclear Studies, developed clearly the social responsibility of the schools as well as the need for a more functional approach to science teaching than has generally been found in the past. The critical need for a reappraisal of the role of the science teacher was analyzed, with particular reference to the teacher education programs in those institutions that prepare science teachers.

The need for a thoughtful appraisal of the present scene by the commission is evident to all who study the kaleidoscopic appearance of science teaching and the preparation of science teachers today. The variegated nature of science teaching and teacher preparation (both pre-service and in-service) attests the makeshift attention being given by some schools to their science programs and the significant possibility of ineffective and inefficient efforts by well-intended but uninformed persons and agencies toward the improvement of the qualifications of teachers. Recognizing that some efforts to help teachers hold much promise, the commission senses the need to assay the present situation in the teaching of science in this country. This need should be met insofar as it is possible to meet it.

The commission has set for itself five initial goals, each to be accomplished in its own way. These five developments are not conceived as being of coordinate value, nor of any essential sequential relationship. It is evident that each has its own potential; each will be developed as rapidly as is feasible. They are:

1. The development of a policy statement for the guidance of the commission. It is anticipated that this document will serve as a guide for the internal functioning of the commission. It is not intended for public distribution, but will be available for study by anyone who wishes to use it.
2. The development of a survey plan by which a "map" of the present known terrain of science education can be studied. Such a document should be of great value to all who have an active concern for the teaching of science in our schools.
3. The development of a plan to study experimental teaching in our schools, with conditions so devised that experimental factors can be identified.
4. The development of a plan to identify and study new directions in science teaching. As with all aspects of educational activity, science teaching responds to many factors, including the development of new knowledge, new insight into the educative process, and new demands by society. Such changes should be identified.
5. The development of a guide which will give direction and help to those who wish to study the science programs in their schools. Techniques of survey and research of science programs are not commonly possessed by those who are concerned and eager to try to improve these programs.

HONE . . . from page 219

are beginning to realize they are teaching conservation when they teach children to appreciate and take care of personal property, school equipment and playground, home yards, and the community park. Conservation must become personal.

It is not simple to develop a conservation curriculum for our times. It is not simple because children in metropolitan schools have daily contact with processed products of basic natural resources. It is not simple because they have only abstract concepts of natural resources, their supply and demand. Should we not help children understand why it is as important to protect city trees and plan for green space in housing developments, as to preserve national forests? Children need to understand how tomorrow's living standard depends on the wisdom with which we use our resources today, whether soil, or steel, or men and women.

You Can Depend on the GENATRON

• *The MODERN Electrostatic Generator*

THE CAMBOSCO GENATRON serves not only for classical experiments in static electricity, but also for new and dramatic demonstrations that are not performable by any other means. It exemplifies a modern method of building up the tremendous high voltages required for atomic fission, for nuclear research, and for radiation therapy.

Entirely self-exciting, the GENATRON cracks into action at the snap of the switch—whose only function is that of starting the motor drive. No auxiliary charging method is employed. Hence, despite an output measured in hundreds of thousands of volts, no hazard is involved, for the operator or for the observers.

An Output of 250,000 Volts—or More!

THE CAMBOSCO GENATRON is designed to deliver, in normal operation, a discharge of the order of 250,000 volts. That figure, a conservative rating, is based on many trials conducted under average conditions. With ideal conditions, a potential difference of 400,000 volts has been achieved.

Modern Design— Sturdy construction and ever-dependable performance distinguish the GENATRON from all electrostatic devices hitherto available for demonstration work in Physics. This powerful, high-potential source, reflecting the benefits of extensive experience in electrostatic engineering, has absolutely nothing but purpose in common with the old fashioned static machine!

NO FRAGILE PARTS—Durability was a prime consideration in the design of the GENATRON which, with the exception of insulating members, is constructed entirely of metal.

The only part subject to deterioration is the charge-carrying belt, which is readily replaceable.

NO TRANSFER BODIES—In all conventional influence machines, whether of Holtz or Wimshurst type, electrical charges are collected and conveyed (from rotating plates to electrodes) by a system of "transfer bodies." Such bodies have always taken the form of metal brushes, rods, button disks or segments—each of which, inevitably, permits leakage of the very charge it is intended to carry, and thereby sharply limits the maximum output voltage.

It is a distinguishing difference of the GENATRON that electrical charges, conveyed by a non-metallic material, are established *directly upon the discharge terminal*. The attainable voltage accordingly depends only upon the geometry of that terminal and the dielectric strength of the medium by which it is surrounded.

Unique Features of the CamboscO Genatron

DISCHARGE TERMINAL Charges accumulate on, and discharge takes place from, the outer surface of a polished metal "sphere"—or, more accurately, an oblate spheroid.

The upper hemisphere is flattened at the pole to afford a horizontal support for such static accessories as must be insulated from ground. A built-in jack, at the center of that horizontal area, accepts a standard banana plug. Connections may thus be made to accessories located at a distance from the GENATRON.

CHARGE-CARRYING BELT To the terminal, charges are conveyed by an endless band of pure, live latex—a CamboscO development which has none of the shortcomings inherent in a belt with an overlap joint.

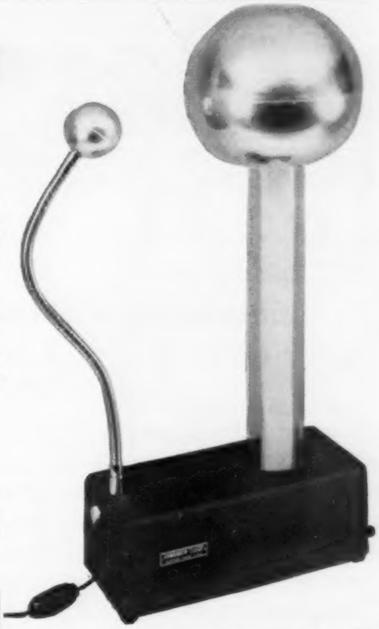
DISCHARGE BALL High voltage demonstrations often require a "spark gap" whose width can be varied without immobilizing either of the operator's hands.

That problem is ingeniously solved in the GENATRON, by mounting the discharge ball on a flexible shaft, which maintains any shape into which it is bent. Thus the discharge ball may be positioned at any desired distance (over a sixteen-inch range) from the discharge terminal.

BASE...AND DRIVING MECHANISM Stability is assured by the massive, cast metal base—where deep sockets are provided for the flexible shaft which carries the discharge ball, and for the lucite cylinder which supports, and insulates, the discharge terminal.

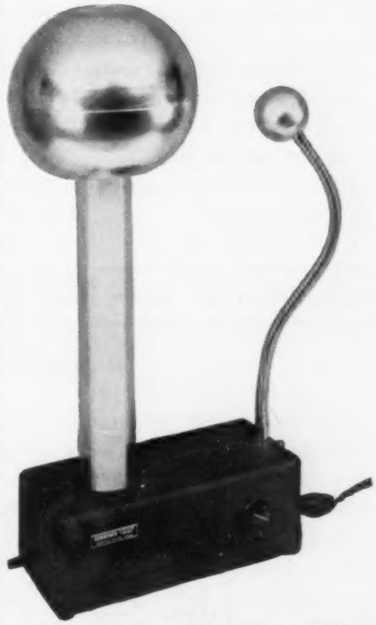
The flat, top surface of the base, (electrically speaking), represents the ground plane. Actual connection to ground is made through a conveniently located Jack-in-Head Binding Post. The base of the Genatron encloses, and electrically shields, the entire driving mechanism.

PRINCIPAL DIMENSIONS The overall height of the GENATRON is 31 in. Diameters of Discharge Ball and Terminal are, respectively, 3 in. and 10 in. The base measures 5¼ x 7 x 14 in.



GENATRON, WITH MOTOR DRIVE
Operates on 110-volt A.C. or 110-volt D.C.
Includes: Discharge Terminal, Lucite Insulating Cylinder, Latex Charge-Carrying Belt, Discharge Ball with Flexible Shaft, Accessory and Ground Jacks, Cast Metal Base with built-in Motor Drive, Connecting Cord, Plug, Switch, and Operating Instructions.

No. 61-705 .... **$98.75**



GENATRON, WITH SPEED CONTROL
Includes (in addition to equipment itemized under No. 61-705) built-in Rheostat, for demonstrations requiring less than maximum output.

No. 61-708 .... **$109.00**

No. 61-710 Endless Belt. Of pure latex. For replacement in No. 61-705 or No. 61-708 .. **$3.00**

CAMBOSCO SCIENTIFIC COMPANY

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Classroom Ideas

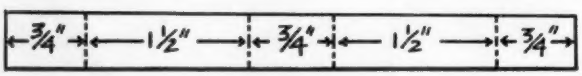
Physics

Constructing a Simple Meter

By CALVIN F. GRASS, Vermont State Teachers College, Castleton

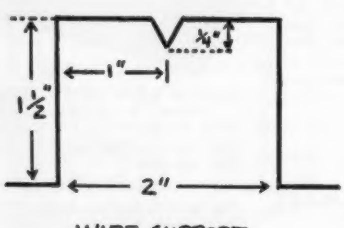
The problem of teaching the principles of meters, motors, and generators is one often met in general science and physics classes. I have had considerable success with the technique outlined below. The materials are those usually found in even the most poorly equipped laboratory or science room. The construction involved is simple even to the point of being crude. However, the technique avoids the mysterious apparatus generally available from commercial suppliers.

The materials needed are: a shoe box or sheet of cardboard, some stiff, bare wire (about 16-gauge but this is not critical), some fine insulated wire (about 28-gauge but again not critical), a pair of scissors, wire cutters, cellophane tape, two common pins, a U-shaped magnet, and one or two dry cells (if more than one dry cell is used, connect them in series). Regular flashlight cells work fine here. Also, you will need two lengths of covered bell or hook-up wire size 18 or 20, each about two feet long.



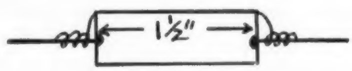
COIL FORM

After having discussed on previous days the magnetic field existing around a wire carrying an electric current, announce that the topic is "The Electric Meter." With your materials in a box



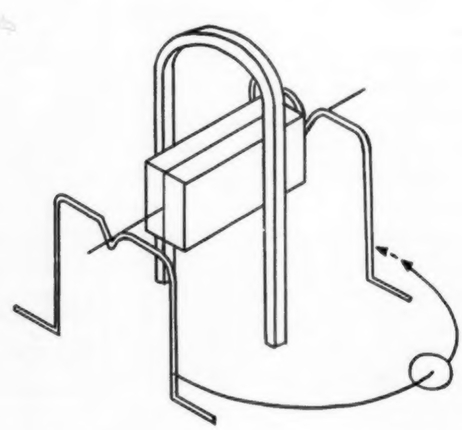
WIRE SUPPORT

or drawer, draw suggestions from the class as to how you could go about making a meter. What parts are necessary? The answers you will be looking for are: a magnet, coil, stand, and a source of electricity to measure. (It is a good idea to have several commercial meters on display if such are available.) For the base, obtain the suggestion of a piece of cardboard, then for supports suggest a piece of stiff, bare wire, bent in the pattern as shown in the diagram. For the armature or coil form suggest a strip (½-inch wide) of cardboard shaped as shown and fastened with cellophane tape.



COMPLETED ARMATURE

The shaft consists of two common pins, one placed at either end of the coil form. Next, bare a piece of the fine wire and wrap around one pin next to the coil form. Now make about 30 or 40 turns with the fine wire around the coil form and attach to the other pin (be sure the end of the wire attached to the pin is bare). If a pointer is desired, tape a small strip of cardboard or stiff paper to



The completed meter solves the "mystery of the black box."

one end of the coil form. Place the completed armature on the support. Put the magnet in place

over the armature as shown in the diagram. Connect one end of the bell wire to one wire support and the other end to the dry cell. Attach a second length of bell wire to the other pole of the dry cell.

Now the big moment has arrived. Will the meter work? Touch the loose bare end of the bell wire to the wire support as indicated. The armature of the meter will move and the pointer will show a deflection. Do this several times for the benefit of the skeptics in the class. Reversing the connections to the dry cell will cause the armature to move in the opposite direction.

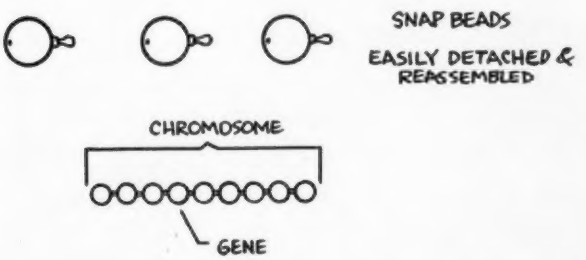
By this crude demonstration you will have reduced the mystery of the 'black box' to a simple device easily comprehended by the class. An interesting class project could follow by having the students construct a motor and generator using the same simple and crude type of apparatus.

Biology

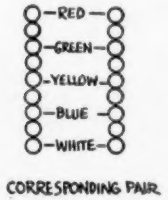
Genes and Chromosomes

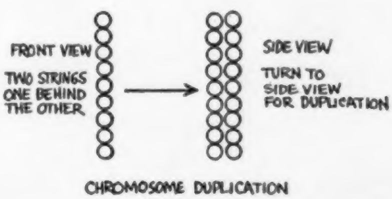
By ARTHUR H. ULRICH, Massapequa, New York, High School

Students frequently encounter difficulty in visualizing chromosomes and their make-up and therefore do not easily grasp the changes which

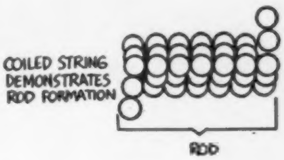


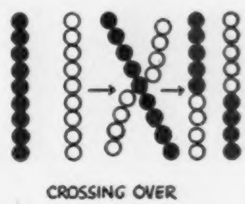
occur during mitosis reduction-division. Snap beads, which can be purchased in any department store, serve as an inexpensive teaching aid in this phase of the study of genetics. The beads are plastic and are available in various colors or can be painted easily. Since the beads are detachable,





they readily lend themselves to quick disassemblement and rearrangement.





Phenomena such as the duplication and coiling of chromosomes, corresponding pairs of chromosomes, and the mechanism of crossing over are more easily understood when thus visually presented. The flexibility of the beads makes it possible to present these various phenomena quickly without doing many laborious and often misleading chalkboard diagrams.

General and Elementary Science

Static Electricity

By M. IRA DUBINS, The School of Education, Northwestern University, Evanston, Illinois

The equipment for this experiment is so readily available that it can be done by the teacher and each student at the same time.

A small piece of paper, a pencil with a sharp point, and a plastic comb or the plastic part of a fountain pen are necessary. Tear a piece of paper one inch in length by one-half inch in width. Fold it along its long axis. Place the paper so that its center point rests on the point of the pencil and make a hole with the pencil so that the paper rests fairly freely on the pencil point.

Hold the pencil with the paper resting on its point in the left hand and, with the right hand, bring the plastic comb or plastic part of the fountain pen very close to the paper. Is the paper attracted to the plastic object? Now run the plastic object through your hair rubbing it against your hair. Bring it close to the paper and see whether there is an attraction. If your hair is dry, the plastic object should have acquired an electrical charge and the paper should be attracted. When you first tried to attract the paper, the plastic object was neutral and there should have been no attraction. The paper is neutral before the plastic object is brought close to it.

NSTA Activities

Board of Directors Actions

The 1957 annual business meeting of the NSTA Board of Directors was held June 28-30 at the NEA Educational Center, Washington, D. C. There was 100 per cent attendance of officers and regional directors. The agenda contained 62 items of business, including annual reports from about 30 committees. Sessions were held Friday morning and afternoon, Saturday morning, afternoon, and evening, and Sunday morning with adjournment set to allow travel time for those who planned to attend the NEA Centennial Convention in Philadelphia. Board action highlights included the following.

1. Expansion of services for elementary school science. Approval was given to increase the *Elementary School Science Bulletin* to eight issues a year and eight pages per issue, compared to the former schedule of six four-page issues. Subscription rates for *ESSB* were set at $1.00 per year for individual subscriptions and 50 cents per year for school group orders of not less than five subscriptions ($2.50) sent to one address. A long-hoped-for staff addition was authorized, namely, a Specialist for Elementary Science. (A report on the new staff member is on page 218.)

2. Recommendation of thorough revision of NSTA constitution and by-laws. This was based on the report of a two-year study by the Committee on Organization and Structure. The proposed new constitution and bylaws will soon be submitted to the membership for balloting. Another product of this committee's work was a complete listing and classification of all policy actions of NSTA Boards of Directors since NSTA was established in 1944. The 1957 Board directed that this listing be turned over to the Policies Committee for codification and recommended revisions, to be submitted to the Board in 1958 as a proposed "policy guide for the conduct of NSTA affairs."

3. Adoption of a budget of $304,000 for 1957-58. This is the largest budget in NSTA history. The following brief summary shows dollar values and per cents of anticipated income and expenses. The latter, of course, also indicate areas of Association service and activities.

Income

Memberships and subscriptions	$ 84,200	28%
Advertising, Packet Service, and convention exhibits	48,000	16%
Sale of publications	20,000	7%
Grants in aid	139,000	45%
Other miscellaneous	12,800	4%
	$304,000	

Expenses

Salaries	$ 62,250	21%
Operational overhead	15,000	5%
Periodical publications, packets	59,000	20%
Convention and conferences	10,000	3%
Committee activities, Board, and Executive Committee	7,500	2%
FSAF, STAR	122,000	40%
Other miscellaneous	28,250	9%
	$304,000	

4. Revision of schedule of dues and subscription rates. Continued rising costs of services, printing, postage, and other items compelled the Board to increase dues and subscription rates to the schedule given on page 205 of this issue of *TST*. A full explanation of the factors and considerations taken into account in reaching this decision will soon be sent to all NSTA members and subscribers.

Packet Evaluators

NSTA's Packet Service has long "won friends and influenced people." Part of its success is due to an unsung group of workers who quietly but faithfully evaluate the many business-sponsored teaching aids which are submitted for possible packet distribution.

This is a large committee—some 100 persons who review and evaluate the materials and whose recommendations are responsible for the items finally selected. But large as the group is, more volunteers are welcome.

If you'd like to volunteer for the 1957-58 school year, please write to NSTA headquarters. State the field or fields of science you are interested in and which you teach, and describe briefly your position and the grade level at which you operate. If you are a supervisor, please state that too.

One thing is sure if you do volunteer: you'll find the work interesting—being in "on the ground floor," that is, on new developments in teaching aids.

Regional Conferences

A continent apart, two meetings will be held in October of significance to science teachers. The first will be the NSTA Northwest Regional Conference which will take place October 11 and 12 at the State College of Washington, Pullman. The theme of this meeting will be "Challenging Students in Science." The keynote speech, scheduled for Friday morning, October 11, will be given by NSTA President-elect Herbert A. Smith.

His topic will be, "Science, A Challenge to the Gifted."

A diversified program for the two-day session will include "Here's How I Do It" presentations and laboratory visits as well as other talks. The chairman of the Northwest Conference is Alfred B. Butler, Associate Professor of Physics at the State College of Washington.

A week later the NSTA Northeast Regional Conference will meet at the Hotel Statler in Hartford, Connecticut. The dates are October 18 and 19. As reported in the May *TST* with other details of this meeting, the theme will be "Improving the Science Program, Kindergarten through College." In his keynote address, Ernest Pollard, of the Department of Biophysics, Yale University, will point out major achievements of science in the recent past and outline the changes he believes will result from this progress.

Among other scheduled speakers is NSTA President Glenn O. Blough who will talk on the elementary school science program in an informal conference summary session at luncheon on Saturday, October 19. The chairman of the Northeast Conference is Frederick W. McKone, of Teachers College of Connecticut, New Britain.

Inaugurating the Calendar as a feature of *THE SCIENCE TEACHER*, the editors plan to list meetings or events of interest to science teachers which are national or regional in scope. Space limitations prevent listings of state and local meetings.

October 1957: National Science Youth Month

October 11-12, 1957: NSTA Northwest Regional Conference, State College of Washington, Pullman

October 18-19, 1957: NSTA Northeast Regional Conference, Hartford, Connecticut

November 6-8 1957: SAMA Laboratory Apparatus and Optical Sections Midyear Meeting, Chicago, Illinois

November 10-16, 1957: American Education Week

November 29-30, 1957: Annual Convention, Central Association of Science and Mathematics Teachers, Chicago, Illinois

December 27-30, 1957: NSTA Annual Winter Meeting with science teaching societies affiliated with the American Association for the Advancement of Science, Indianapolis, Indiana

March 26-29, 1958: NSTA Sixth National Convention, Denver, Colorado

April 24-25, 1958: 1958 Eastern States Health Education Conference, New York Academy of Medicine, New York City

FSA Activities

Roster of Sponsors

Despite the summer "lull," the 1957 roster of sponsors of the Future Scientists of America Foundation has continued to increase. By mid-July, 47 business-industry organizations had made financial grants to FSAF, thereby giving evidence of their belief that the FSAF program is a constructive one in helping to develop future scientists.

The following are the 1957 sponsors not previously listed in *TST*.

Ethyl Corporation
P & H Harnischfeger Corporation
The Pittsburgh Plate Glass Foundation
Standard Oil Company (Indiana)
Vanadium-Alloys Steel Company

Cooper-Bryan Report

The press as well as industry and education has given an enthusiastic reception to the new FSAF booklet, "Summer Employment of High School Science Teachers." Published in June, it is in great demand both because of the unique quality of the study it reports and its cogent presentation of the facts.

Attractively-designed, the 30-page booklet presents a summary of practices followed by 92 companies in their teacher summer employment programs. The report was prepared by Edwin Cooper, of Madison High School, Madison, New Jersey, with Dr. Ned Bryan, of the School of Education, Rutgers University, New Brunswick, New Jersey, acting as project advisor. The report is illustrated and presents color charts of highlight facts determined by the study.

Single copies of the report are free on request. They are obtainable from the National Science Teachers Association, 1201 Sixteenth Street, N.W., Washington 6, D. C.

Administrative Committee

In one of his first official actions in his new post, NSTA President Glenn O. Blough has re-appointed Dr. Philip G. Johnson to the FSAF Administrative Committee. Dr. Johnson, of Cornell University, Ithaca, New York, will serve another three-year term, for the period ending June 30, 1960.

President Blough's action leaves only one vacancy on the ten-man committee. The retiring member of the group is Dr. Henry H. Armsby, of the U.S. Office of Education, Washington, D.C., who has earned deep appreciation for his tireless work during five years of service on the committee.

Four members of the committee are carryovers. They are Dr. Thomas Osgood, Michigan State University, East Lansing, and Miss Katherine Hertzka, Hoke Smith High School, Atlanta, Georgia, whose terms have one more year to run, until mid-1958. The other two are Dr. Stanley Williamson, Oregon State College, Corvallis, and Dr. Samuel L. Meyer, dean of Central College, Fayette, Missouri, whose terms have two more years to run, until June 30, 1959. Dr. Williamson is the group's 1957-58 chairman.

The remaining four members are automatically members of the committee. They are Dr. Blough, as NSTA president; Dr. Herbert A. Smith, Professor of Education, University of Kansas, Lawrence, as NSTA president-elect; Dr. Robert T. Lagemann, Chairman, Department of Physics and Astronomy, Vanderbilt University, Nashville, Tennessee, as NSTA treasurer; and Robert H. Carleton, as NSTA executive secretary.

SAA Awards

Plans for the 7th annual program of Science Achievement Awards for Students are now completed and announcements of the details will be mailed this month. As in past years, the program is being sponsored by the American Society for Metals and the awards will include special national awards for projects dealing with metals and metallurgy as well as regional awards for projects in any scientific field. The latter will be made on a grade basis within each region.

On the basis of experience in past years, FSAF officials anticipate that the 1958 program will draw requests for entry forms and other materials up to 20 per cent greater in terms of student participation than last year. The number of forms requested last year was nearly 27,000 and this figure does not include requests which could not be filled because of incomplete addresses or those which were received too late to meet the program deadline.

September is not too early for teachers to start their students working on projects for the SAA program. The deadline for entries will again be mid-March, which may seem a long time away. But the judges in the 1957 program reported there were quite a few instances in which students noted in their project reports that they hadn't had time to do as much work as they would have liked to—and the students expressed their regret they hadn't started earlier. So—help your students begin work now!

COHEN . . . from page 215

our college courses as it is in our high school courses —is that science is *interesting*, science is *exciting*, science stimulates the imagination; that there isn't anything more wonderful and more exciting than to contemplate the infinite universe and the tiniest, smallest parts of matter. But I find that students do not learn this. The difficulty they face, they tell me, is that there is so much factual material to remember, so many laboratory techniques, and so many types of problems to solve, that in the end they don't even know what science is. This is true of high school seniors and college seniors equally.

One of the things that gives me the greatest pleasure when I give college courses in the history of science is that some students every year—not many of them, I regret to say, but some—come to me and say, "This has been a wonderful experience. I have taken courses in chemistry (or physics, or biology, or all of them put together). But I never knew what was going on. I never knew why anybody did this or that. Metchnikoff was a Russian and Wöhler was a German. But who were they? Why did they do what they were doing? What moved them? What is science? Now, I begin to understand."

This is important. Why? Because *science is the creation of human minds*. It is the interaction of the mind with the experience of nature and with the special experience of the laboratory. It is this interaction which is exciting.

How can the teacher make this exciting? I do not think anyone should say: Teach the history of science in place of science. To me, this would be an abomination. But I think there might be a point somewhere in every science course to bring in one historical example.

I do not mean an announcement of the fact that Pascal was a Frenchman, born in such a year and died in such a year. Nobody cares about that. Biography is important only if it presents the mentality of the man.

Take Galileo, as an example. What was Galileo doing? He believed in the Copernican system, and the Copernican system said the earth must be another planet. Galileo looked out at the heavens through the newly-invented telescope in the year 1609. Suddenly he saw the universe, as he said, as it had existed since God had created it, thousands and thousands and thousands of years ago, through all the centuries before man had the instrument for seeing it. Too, there were thousands of stars which had existed since the creation, and no living man had seen them until Galileo looked. Here were the

moons of Jupiter and no one had ever seen them. Here were the phases of Venus and the mountains on the moon. Everyone had looked at the heavens and no one had been able to see them.

This is the exciting moment! Suddenly to find out what's there, how it is put together. If one can make that moment real, can the student help but be stimulated?

The student should learn, too, that science is built up of questions. This is the second thing which I believe is important. We are so anxious to teach what is known that we have difficulty in getting to the unknown. The unknown is the future; the known is history. It seems to me, looking back on the history of science, that people who study the sciences learn answers—and then tend to forget that the answers represent questions. A bit of history, once in a while, would show that these *were* questions, that the answers we have came because men with inquiring minds, imagination, and the discipline required for science, studied fundamental questions.

I have said that to work toward creativity in the realm of ideas is a social obligation. It is particularly, I think, a social obligation of science teachers, because it is important for our society that we have men of science who have imagination and who can produce the great new ideas of the future just as they were produced in the past.

Looking back at the history of science and trying to find if there is any other reason why we might not be producing the men of science we need, I think there is one other factor. Let me put it this way:

What science needs for its progress, on the part of its individuals, is creative imagination. The second thing it needs is discipline. The scientist has to be able to express the products of imagination in a language. Hence, it would follow, the two major things a scientist needs—and I think he needs them even more than money—are creative imagination and the discipline of exact thought.

Exact thought in science consists of two things: It consists, in the first place, of mathematics—and the need for teaching mathematics is therefore clear. But it also consists in thinking in words. Unfortunately, our thinking in words is strongly limited today, because our science students—even the most able of them in college—have a limited vocabulary, have no sense of grammar, do not know what words mean, do not know their precise limitations, and cannot use them exactly.

I would say, therefore—and this may come as a bit of a shock—that what we need in teaching science is precision in the language of mathematics and *instruction in language itself*.

In my opinion, it would be worth-while to bring back into the curriculum a little of the study of Latin. This would enable our students to see how language is put together and where words come from. They would be able, therefore, when they come to think about scientific problems, to know what words they are using, how language works, what is grammar, and what is rhetoric.

Plainly, the history of the 19th century has given us a legacy of society in relation to science which we cannot simply throw over by one or two simple remedies. All we can hope to do, it seems to me—teachers of science in the secondary schools, teachers of science in college, and those like myself who are interested in the development of science as part of the main stream of ideas—is to do what we can along the line that will at least give the student some feeling for what the scientific experience is. If we can instill in him a little sense that science is the result of creative imagination and precision in thinking in words and in mathematics, our pursuit of this social goal will have meant that our endeavors have been of the highest level and well served.

Book Reviews

SCIENCE TEACHING IN SECONDARY SCHOOLS. John S. Richardson. 385p. $6.50. Prentice-Hall, Inc., Englewood Cliffs, N. J. 1957.

Here is a text clearly designed for prospective teachers of science in junior and senior high schools. It is worthy of consideration for use in students' first "science teaching methods" course, taken either concomitantly with or immediately following a course such as "general methods of high school teaching"—either at the upper division or the graduate level.

The author has given thorough attention to those areas of science teaching which are common to "teaching of science" courses. The opening pages treat the nature of science and its role in the education of youth and in modern society. A later chapter explores the scope of secondary school science offerings, the relations between science and other facets of the school program, and the ways in which science participates in a variety of contemporary high school curriculum patterns. Science teaching methods and procedures are treated in a pair of chapters, one devoted to laboratory work, demonstrations, and projects; the other, to classroom and field experiences such as lectures, committee work, and excursions. A large chapter is concerned with scientific methods of thinking, including a discussion of the nature of problem solving, suggested learning experiences, and ways of evaluating student growth in this area. Closely related to this chapter is the unique appendix consisting of an extensive classified set of suggested practical hypotheses in science with brief suggestions as to how students might develop tests for each.

Materials and resources for science teaching are treated in three chapters. One of these gives a penetrating treatment to free and inexpensive materials in general and provides an exceptionally extensive list of government publications, commercially produced pamphlets, folders, and charts, equipment catalogs, and resource compilations of audio-visual materials. Another section points out the applications of display techniques, museums, and collections to science teaching. A third chapter gives special attention to the science teacher's use of photography, projected materials, recordings, radio, and television. An unusual section is devoted to the planning of new science classrooms and laboratories and to adapting and improving existing facilities. Another welcome addition to the "expected coverage" is a closing chapter entitled "Growing Professionally."

Interspaced with chapters treating the "standard" areas above are others which deal with more general aspects of high school teaching. These include principles of the psychology of learning, evaluation of student growth in science, preparation of lesson plans and units of work, and guidance in the science teaching enterprise. These topics, although general in nature, are approached from the science teacher's viewpoint and include numerous applications and examples selected from science classroom situations. The inclusion of such materials in the book emphasizes the solid relation between science teaching and modern educational psychology, and would serve particularly well the needs of institutions where "special methods in science" is taught in conjunction with "general methods of high school teaching."

This is not a book which features teacher "how-to-do-it" skills and student learning activities in science, nor is there any attempt to handle science "subject matter." The author recognizes the value of these and makes abundant reference to their treatment elsewhere. His handling of all chapters is most generous in its provision of practical illustrative examples. In the main, however, he has confined his attention to the theory and practice of effective science teaching in today's high schools.

ROBERT STOLLBERG
Professor of Physical Science
San Francisco, California, State College

TEACHING SCIENCE IN THE SECONDARY SCHOOL. R. Will Burnett. 382p. $5.25. Rinehart and Company, Inc., New York. 1957.

As in no other book with which I am familiar, this text reports the theory and practice of science teaching in a lucid and integrated fashion. Research findings and modern psychology are used in analyzing science teaching. Practices and trends are considered both in terms of expressed aims and practical limitations.

The author begins by presenting the basic problems that must be met by the teacher if science teaching is to be effective. Older methods and newer practices are compared in terms of these problems. Research is related as it applies to the development of a scientific approach to living, critical thinking, and to the acquisition, retention, and use of knowledge. The psychological basis for the newer approaches to the teaching of science is clearly stated.

Many specific suggestions for the improvement of classroom practices are given. These include ways to provide functional laboratory, demonstration, lecture, discussion, and evaluative experiences.

Part IV of the text presents several procedures and practices which illustrate the problem approach to science teaching. It consists mainly of separate articles written by experienced teachers. Each chapter illustrates certain of the theories stated earlier.

Part V deals critically with the profession of science teaching, reports its present status, and suggests what one may do to keep up professionally.

From the standpoint of helping a science teacher determine what to do when teaching science, and how to do what he undertakes, this book is indispensable. I recommend it as a must for everyone making science teaching a profession.

N. ELDRED BINGHAM
Professor of Education
University of Florida, Gainesville

SOIL—USE AND IMPROVEMENT. J. H. Stallings. 403p. $5.95. Prentice-Hall, Inc., Englewood Cliffs, N. J. 1957.

This text was designed for vocational agricultural courses, but it will serve as an excellent reference for general science

and conservation as well. Its three major divisions consider the historical aspects of soil conservation, fundamental considerations, and modern practices.

The author points out a fact which many may not be aware of at this time. For several thousand years, man has felt that surface runoff was the prime cause of soil erosion, but in recent decades it has been found that raindrop splatter on uncovered ground is a serious cause of erosion. The author develops this thought quite thoroughly.

Many excellent illustrations are to be found which point out both the undesirable practice and the measures which retain and build soil quality. The book effectively develops the concept that no one good soil practice is a panacea. Differences in soil, slope, crop, climate, etc., may require different approaches. On any one farm there may be a dozen or more different soil conservation practices in use at the same time. The author shows how to develop a land use plan which will enable the farmer to conserve and build the quality of his soil.

JAMES E. RICHARDS JR.
Roosevelt Junior High School
North Bend, Oregon

MAN'S PHYSICAL UNIVERSE. Arthur Talbot Bawden. 822p. $6.25. The Macmillan Co., New York. 1957 (Fourth Edition).

There are many different types of physical science courses given, including both the survey and the block and gap type. This text appears to be applicable in both these types.

There is a generous treatment of the methodology of science followed by subject matter from the fields of astronomy, geology, physics, and chemistry. Each section is done in sufficient detail to provide enough subject matter for a comprehensive block of material. The text presents scientific principles and also a wealth of applications of science in everyday life.

Study questions are given at the ends of the chapters but biographical references are omitted. The reviewer was well pleased with the book.

IRWIN H. GAWLEY
State Teachers College
Upper Montclair, New Jersey

BOOK BRIEFS

THE CHEMICAL HISTORY OF A CANDLE. Michael Faraday. 158p. $2.75. Thomas Y. Crowell Company, New York. 1957.

The lectures delivered by the British scientist at the Royal Institution in London in 1860 are reprinted here and the book proves again that his talks to a group of young people are a classic in scientific exposition. As timely today as they were when delivered, the lectures provide an exciting introduction to the world of chemistry.

NEA: THE FIRST HUNDRED YEARS. Edgar B. Wesley. 419p. $5.00. Harper & Brothers, New York. 1957.

Published in the National Education Association's centennial year, this book, subtitled "The Building of the

Teaching Profession," is a detailed and thoughtful review of the growth and varied programs of the American teachers' organization. It is not only a history of NEA but also a presentation of the organization's development and that of education itself in the light of American social and intellectual history. The author, visiting Professor of Education at Stanford University, has enlivened the text with vignettes of early classroom activity. Covering such topics as the growth of high school enrollments, the rapid expansion of higher education, and the extension of Federal aid to education, it points to the ever-increasing respect in which the teaching profession is being held. It is, of course, a book for teachers—but it is also a book for the general public, parent or not.

CHEMISTRY: A BASIC SCIENCE. John C. Hogg, Otis E. Alley, and Charles L. Bickel. 801p. $4.75. D. Van Nostrand Company, Inc., Princeton, N. J. 1957.

A revision of the book titled "Chemistry: A Course for High Schools," this is a fourth edition of a text which has been widely used since its first appearance in 1945. Keeping apace of new developments in the field of chemistry, this edition includes a completely rewritten and expanded presentation on atomic energy. Increased from two to four chapters, this section emphasizes the tremendous potential of atomic power in peaceful uses.

FRONTIERS OF ASTRONOMY. Fred Hoyle. 352p. 50¢. New American Library, New York. 1957.

A paperback reprint, this book sets forth the intriguing new theories on how the stars and planets were formed, how the sun operates internally to provide its tremendous flow of energy, and how the constant creation of hydrogen affects the expanding universe. Profusely illustrated, it also discusses the controversial issue of the origin of the universe. It is one of the books that make particularly timely reading during the International Geophysical Year.

RUTHERFORD: ATOM PIONEER. John Rowland. 160p. $4.75. Philosophical Library, New York. 1957.

Considered one of the outstanding scientists of all time and possibly the greatest figure in the 20th century world of atomic physics, Ernest, Lord Rutherford of Nelson, makes a fascinating biographical subject. Born in New Zealand in 1871, he was to travel extensively and to earn his scientific distinction in Canada and Great Britain. This biography presents the facts of his personal life as well as those of his career and it is enriched with anecdotes of his work and his associations.

THE PRINCIPLES OF HEREDITY. Laurence H. Snyder and Paul R. David. 507p. $6.25. D. C. Heath and Company, Boston. 1957.

This is the fifth edition of what is probably the leading introductory text in the field of genetics. Comprehensive and thorough, richly illustrated, it is written knowledgeably and in a direct style which holds the reader's interest while it instructs. The new edition represents extensive rewriting as well as a considerable rearrangement of material. It includes new chapters—on giant chromosomes and the genetics of bacteria and viruses—and it omits the fourth edition's final chapter on the analysis of human pedigrees which users of the text had criticized as not assigned to students.

Audio-Visual REVIEWS

BIG LAND ANIMALS OF NORTH AMERICA. 11 min., 1956. $50 B & W, $100 Color. Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill.

Recommendation: Especially appropriate for upper primary and middle grades but of interest to all age groups.

Content: Drawings of mountain sheep, mountain goats, deer, elk, moose, caribou, reindeer, buffaloes, and bears are placed on a map of North America. One by one, each of these animals is shown in its natural habitat, and its outstanding habits, enemies, and means of protection are pointed out by the commentator.

Evaluation: A valuable film for teaching about animals in the upper primary and middle grades. Printed captions of the names of the animals would be an effective addition. An excellent teacher's guide should be carefully studied before and after showing the film.

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THE OSTRICH. 7 min. $70 Color. International Film Bureau Inc., 57 E. Jackson Blvd., Chicago 4, Ill.

Recommendation: Nature study and general science areas at all grade levels.

Content: Showing ostriches in their natural habitat on the Karroo in South Africa, the film tells how they feed and move, their nesting habits, and how the young are protected by camouflage. Particularly interesting are the close-up details of legs, feet, neck, and head.

Evaluation: Very good photography and instructional qualities. The film has a clever musical score.

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USING THE LABORATORY. B & W, Color. Coronet Instructional Films, Coronet Bldg., Chicago 1, Ill.

Recommendation: Senior high school science areas.

Content: Planned to help students develop good techniques and attitudes in laboratory work in the physical or natural sciences, the film provides an effective demonstration of laboratory skills and usage. There is emphasis on experimentation, objectivity, accuracy, and safety procedures and attitudes.

Evaluation: A well organized film giving adequate coverage of the topic. As an attitude building film, it can be profitably used at the beginning of the semester.

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UNDERSTANDING FIRE (Exploring Science). B & W, Color. Coronet Instructional Films, Coronet Bldg., Chicago 1, Ill.

Recommendation: Primary and intermediate grades in science areas.

Content: This is a simply told story of a boy and his curiosity about fire. As Billy watches a fire in an outdoor fireplace, he begins to think about fire—its uses and characteristics. He realizes that the more control we have over fire, the more useful it can be, and, remembering certain school experiments, he begins to develop a basic understanding of fire's three requirements: oxygen, fuel, and heat.

Evaluation: Well organized content which is interest stimulating and serves to increase a child's understanding of fire. In one instance, the father violates a safety rule when he extends his arm over fire. A teacher's guide comes with the film.

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WHAT GOES INTO THE BLAST FURNACE. 15 min. $70 B & W. **IRON MAKING.** 13 min. $65 B & W. **WHAT COMES OUT OF THE BLAST FURNACE.** 8 min. B & W. International Film Bureau Inc., 57 E. Jackson Blvd., Chicago 4, Ill.

Recommendation: Junior and senior high school levels in general science and chemistry areas.

Content: The three films, which can be used singly or as a group, are rather closely related in coverage and content. Diagrams and animated drawings are employed. The first film shows the construction of a blast furnace, its operation, and the materials used. The second film treats in some detail the chemical processes and formulas in the operation of a blast furnace and deals as well with the raw and processed materials involved. A most interesting sequence illustrates by formulas and animation the chemical changes that occur in a furnace. The third film discusses the products of a blast furnace, the method of removing them, and the uses to which they are put.

Evaluation: Well organized and well photographed, though the treatment is somewhat prosaic. The films provide excellent background and factual material and should promote research in the area of steel production.

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AMPHIBIANS. 11 min., 1957. B & W, Color. Coronet Instructional Films, Coronet Bldg., Chicago 1, Ill.

Recommendation: Grades 4 through 8 in natural science areas.

Content: The film presents the following sequences: a frog egg mass in spring, baby frogs (called tadpoles) emerging, the tadpole's breathing, his food, the development of his legs, the change to lung breathing, the disappearance of the tail, and the emergence of the adult. The terms amphibian, spiracle, vertebrate, metamorphosis, cold-blooded, hibernation, and camouflage are explained with illustrations.

Evaluation: A better than average film which, however, needs more than the two printed captions used. The drawings will require further explanation by the teacher. An excellent teacher's guide accompanies the film.

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LET'S CATCH REPTILES. 10 min., 1949. B & W, Color. Bailey Films, Inc., 6509 De Longpre Ave., Hollywood 28, Calif.

Recommendation: Grades 3 through 5 in science areas.

Content: A Saturday morning outing to a nearby stream by three children is the plot device through which the catching, care, and subsequent release of reptiles are shown. Animals caught or observed are the brown-shouldered lizard, horned lizard, tortoise, blue-bellied skink, and king snake. The children use oat straw nooses to catch the small animals without harming them.

Evaluation: Good pacing and commentary. The plot effectively involves the viewer with the children depicted.

Activities of NSTA AFFILIATES

►Four new groups were approved as NSTA affiliates by the Board of Directors at its June meeting. They are the PINELLAS COUNTY (Florida) SCIENCE TEACHERS ASSOCIATION, the SOUTH CAROLINA SCIENCE TEACHERS ASSOCIATION, the COLORADO SCIENCE TEACHERS ASSOCIATION, and the SPOKANE (Washington) SCIENCE TEACHERS ASSOCIATION. The officers of the Florida group are: Joseph A. Johnson, *president;* Mrs. Garnelle Jenkins, *secretary;* and Mrs. Margaret Hart, *treasurer,* all of St. Petersburg; and Leroy Hooks, *vice-president,* of Clearwater.

►The COLORADO SCIENCE TEACHERS ASSOCIATION is a new organization. It was formally established last April and its constitution provides that all its members will also be members of NSTA. The officers are: *president,* Larry Watts, South High School, Denver; *vice-president,* Glen Geisert, Central High School, Pueblo; *secretary,* Joe Shoemaker, College High School, Greeley; and *treasurer,* Joe Pierce, Durango.

►The WEST VIRGINIA SCIENCE TEACHERS ASSOCIATION has elected Lyle Plymale president for the 1957-59 term. He is a biology teacher at Vinson High School, Huntington.

►The ILLINOIS ASSOCIATION OF CHEMISTRY TEACHERS has scheduled its fall meeting for October 18 on the University of Illinois campus. Program plans call for papers on the covalent bond, complex ions and coordination compounds, and resonance. The program is being arranged by the Association's president, Dr. Carl Weatherbee of Millikin University, Decatur, and Dr. David Curtin of the University of Illinois chemistry staff.

►The CONNECTICUT SCIENCE TEACHERS ASSOCIATION has announced its new officers for 1957-58. They are: *president,* William H. Scheld; *1st vice-president* (program), David Blick; *2nd vice-president* (membership), Henry Kuligowski; *secretary,* C. Robert Rittner; and *treasurer,* John Prymak. Reporting on the past school year's activities, the CSTA Newsletter pointed out that thanks to generous contributions from ten Connecticut industries, 31 CSTA members were flown by chartered plane to and from Cleveland last March to attend the NSTA 5th National Convention.

►A change of name has been reported from Virginia. It is now the VIRGINIA ASSOCIATION OF SCIENCE TEACHERS instead of the Secondary Science Section of the Virginia Education Association. The group's president is Felix Sanders. Richard Weakley is president-elect and Barbara Vavrek is secretary.

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